

Fish Consumption Rate Technical Support Document

Draft 5\_0

June 17, 2011

This is a working draft. Please do not distribute.

Questions to reviewers:

- Does the draft document appropriately characterize Washington's fish consuming populations? (Chapters 2 & 4)
- The draft report identifies a range of fish consumption rates for consideration during the regulatory process. Are the approaches used to identify that range consistent with current information and statistical methods? (Chapter 7)
- Should salmon be included when developing one or more statewide default fish consumption rates? (Chapters 2 & 6 and Appendix E)

PLEASE NOTE: work on the analysis in Chapter 7 is not yet reflected in the Executive Summary.



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DEPARTMENT OF  
**ECOLOGY**  
State of Washington

# **Fish Consumption Rates**

## **Technical Support Document**

*A Review of Data and Information About Fish  
Consumption in Washington*

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# **Fish Consumption Rates**

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## **Technical Support Document**

Toxics Cleanup Program  
Washington State Department of Ecology  
Olympia, Washington





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## Acronyms & Abbreviations

API	Asian and Pacific Islander
bw	body weight
BRFSS	Behavioral Risk Factor Surveillance System
CRITFC	Columbia River Inter-Tribal Fish Commission
CSF	cancer slope factor
CSFII	<i>Continuing Survey of Food Intakes by Individuals</i>
DOH	Washington Department of Health
EPA	U.S. Environmental Protection Agency
FDF	fish diet fraction
LEKT	Lower Elwha Klallam Tribe
µg/L	micrograms per liter
µg/mg	micrograms per milligram
MTCA	Model Toxics Control Act
ODEQ	Oregon Department of Environmental Quality
OFM	Office of Financial Management
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PBT	persistent bioaccumulative toxic
PCB	polychlorinated biphenyl
PFMC	Pacific Fishery Management Council
RfD	reference dose
RME	reasonable maximum exposure
SaSI	salmon stock inventory
SMS	Sediment Management Standards
USDA	U.S. Department of Agriculture
WDFW	Washington Department of Fish and Wildlife
WRIA	water resource inventory area
WQS	Water Quality Standards for Surface Waters
WPA	Watershed Planning Act

# Executive Summary

June 15, 2011

## Problem statement

Washington's aquatic resources provide tremendous benefit to the people of the state. Large quantities of fish and shellfish are caught annually, both recreationally and commercially, and many residents eat seafood harvested from our waters. In addition, tribal populations enjoy treaty fishing rights, and harvesting and eating seafood plays a significant role in their cultures.

PCBs (polychlorinated biphenyls), dioxins, mercury, and other persistent chemicals can accumulate in fish tissue and harm the health of people who consume fish. People who eat large amounts of fish or shellfish, children, and other sensitive populations may be particularly vulnerable. Current fish consumption rates that the Department of Ecology uses for regulatory decisions are not consistent with what we know about how much fish people in Washington eat.<sup>1</sup>

Ecology is in the process of considering revisions to the Sediment Management Standards (SMS) rule (WAC 173-204). Over the next several years, we will consider updates to the Water Quality Standards for Surface Waters (WAC 173-201A), and the Model Toxics Control Act (MTCA) Cleanup Regulation (173-340). During these efforts, Ecology will review a variety of policy, technical and scientific issues.

One question being considered is how fish and shellfish consumption should be taken into account when making regulatory decisions. The initial focus is how fish consumption rates are used in making cleanup decisions. Revisions to the SMS will address establishing cleanup levels protective of high fish consumers; that is, revisions are being considered that will incorporate fish consumption rates used in calculating sediment cleanup levels low enough to protect people who eat a lot of fish.

Ecology plans to revise the Surface Water Quality Standards to adopt human health-based criteria that incorporate Washington fish consumption rates in a later process. The information in this report and the Sediment Management Standards rule revision will likely strongly influence the rates included in future human health-based water quality criteria.

## Current regulatory situation

Ecology currently recognizes two separate default fish consumption rates used to establish regulatory requirements:

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<sup>1</sup> Ecology has the ability to make site specific decisions and use site specific information, including fish consumption rates protective of tribal populations. One of the questions being addressed here is identifying a default fish consumption rate that can be considered generally protective of Washington fish consumers.



- The MTCA Cleanup Regulation includes a default fish consumption rate of 54 grams (1.9 ounces) per day. This value was established in 1991. It is based on information from a survey of Washington recreational anglers in Commencement Bay.
- The Water Quality Standards for Surface Waters references the National Toxics Rule. The rule includes water quality standards for human health protection based on a fish consumption rate of 6.5 grams (0.22 ounces) per day. This value is based on technical evaluations completed by the U.S. Environmental Protection Agency (EPA) in the mid-1980s.

## **Regulatory question**

There have been many scientific and regulatory developments related to fish consumption rates over the past 20 years. Ecology is evaluating this information to answer this question:

What is a technically defensible default fish consumption rate (or rates) appropriate for use in regulatory decision making? Key considerations are:

- Recent scientific data on fish and shellfish consumption rates for different population groups.
- Approaches used by other state and federal agencies.
- Uncertainty and variability in fish and shellfish consumption rates for different population groups and individuals within those groups.
- Current and potential future exposures resulting from fish and shellfish consumption.
- State laws and policies, including MTCA and the Water Pollution Control Act.
- Treaty-reserved fishing rights.

## **The aquatic environment challenge**

In an aquatic environment, contaminants move between water and sediment and from one location to another. There are many different fish and shellfish in Washington waters, each with a unique life history and preferred habitat. The various salmon species, like other anadromous fish, migrate between river and open ocean environments, spending only a portion of their life near shore. Others, like oysters, are stationary.

Effluent discharges can cause sediment contamination, resulting in bioaccumulation of contaminants in fish and shellfish and potentially unacceptable risks to consumers. Ecology recognizes the complexity of addressing this issue. There is considerable challenge in finding a workable science-based and data-driven framework that links source control and cleanup. We believe that updating fish and shellfish consumption rates appropriate for use in cleanup decisions provides an important first step.

## **Purpose of this technical support document**

This Technical Support Document provides useful background information for discussions related to fish consumption rates. A number of questions are considered:

- How many people in Washington can be identified as “high fish consumers?”
- What is currently known about the fish consumption habits and rates for different population groups in Washington?
- What information should Ecology include when considering statewide default fish consumption rates?
- What factors should be considered in establishing site-specific fish consumption rates?

Ecology recognizes that other exposure parameters (such as exposure duration) are part of the equations used in calculating protective standards. This document, however, focuses specifically on technical information related to fish consumption rates.

## Washington fish consumers and high fish consumers

Ecology estimates that Washington has between 1.4 million and 3.8 million adult fish consumers. This includes a large number of recreational anglers. The number of adult fish consumers is projected to increase up to 27 percent over the next 20 years. Ecology also estimates that Washington has about 290,000 children (under 18 years old) who are fish consumers.

A convenient way of defining “high fish consumers” is using national data about dietary habits. The US Department of Agriculture collects data about US food consumption. For the purposes of this report, Ecology used information from EPA about fish consumption based on the national data. To obtain a rough estimate of how many people eat the most fish, Ecology defined “high fish consumers” as the people who eat more fish than 90% of other fish consumers in the nation.

The agency estimates that between 146,000 and 384,000 Washington adults and about 29,000 children can be considered high fish consumers. Ecology based these estimates on data from EPA on national fish consumption rates for the general U.S. population applied to Washington census data and information collected by the Washington Department of Health.

The number of high fish consumers in Washington depends on how “high” is defined. For purposes of this report, Ecology defines “high fish consumers” as adults who eat more than 250 grams (8.8 ounces) of fish and/or shellfish per day and children who eat more than 190 grams (6.7 ounces) per day. These definitions correspond to the 90<sup>th</sup> percentile fish consumption rate for fish consumers reported in a 2002 EPA national survey.

There is uncertainty associated using national survey data to characterize Washington fish consumers. Although the national survey results may overestimate the amount of fish consumed by the general population, it may not completely characterize Washington consumption habits. Moya (2004) found that people living in coastal states tend to eat fish and shellfish more often and at higher rates than people in inland states.

Additionally, Asian and Pacific Islanders and Native Americans in Washington are known to consume large amounts of fish and shellfish. In this report, Ecology also considers available data about fish consumption rates for these population groups.

## Level of protection

When considering the risk coming from contamination in fish and shellfish, exposure is typically assumed to be distributed across a population. Some people eat considerably more fish and shellfish than other people. Individuals at the high end of the exposure distribution, typically considered as those between the 90<sup>th</sup> and 99<sup>th</sup> percentiles, are particularly at risk. Regulatory efforts aim to set standards that protect individuals at the upper end of the exposure distribution.

MTCA risk policies identify the range of the 90<sup>th</sup> to the 95<sup>th</sup> percentile as appropriate for setting high-end exposure estimates for fish consumption. This represents a reasonable, but not worst case, maximum exposure estimate. Ecology believes that this range is appropriate for developing default fish consumption rates that fall within the actual distribution of Washington fish consumers.

Washington's water quality and cleanup regulations are designed to protect consumers who eat fish harvested from Washington waters. Some groups of people are considered sensitive populations because of their high fish consumption rates and susceptibility to contaminants. (For example, children can be considered a sensitive population.) Ecology recognizes that there are situations where it is appropriate to consider site-specific exposure scenarios, to better account for sensitive populations.

## Data about Washington fish consumers

Ecology evaluated known available survey information on fish consumption in the Pacific Northwest. We based evaluations on specific measures of technical defensibility, including:

- Survey methodology.
- Survey execution.
- Publication of results.
- Applicability and utility for regulatory decisions (for example, representativeness of the population surveyed relative to the regulatory decision).
- Technical suitability for the decisions.

Ecology concluded that these five surveys should be considered when establishing a statewide default fish consumption rate:

1. *A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin* (CRITFC, 1994).
2. *A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region* (Toy et al., 1996).
3. *Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservations, Puget Sound Region* (Suquamish Tribe, 2000).
4. *Asian and Pacific Islander Seafood Consumption Study* (Sechena et al., 1999).

5. *Estimated Per Capita Fish Consumption in the United States* (EPA, 2002). (Because the methodology used for this survey differs considerably from the other surveys it may be inappropriate to directly compare the data. It does, however, provide additional useful information about fish consumption in the general population.)

**Table 1. Summary of Fish Consumption Rate Survey Data**

	Population Surveyed	Type of Fish Included in Survey	Number of Adults Surveyed	Descriptive Statistics (g/day)					
				Mean	Median	Percentiles			
						75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	99 <sup>th</sup>
Data from dietary recall surveys	Tulalip Tribe	Finfish (anadromous & estuarine) Shellfish	73	72	45	85	186	244	312
	Suquamish Tribe	Finfish (anadromous & estuarine) Shellfish	284	214	132	-	489	-	-
	Squaxin Island Tribe	Finfish (anadromous & estuarine) Shellfish	117	73	43	-	193	247	-
	Columbia River Tribes	Finfish (anadromous & Freshwater)	512	63	40	60	113	176	389
	Asian & Pacific Islanders	Finfish (anadromous & estuarine) Shellfish	202	117	78	139	236	306	-
EPA estimate	Fish consumers in the U.S. general population	Finfish (anadromous, estuarine, marine, & freshwater) Shellfish	2585	127	99	-	248	334	519

Source: Adapted from Table 3, page 28, Human Health Focus Group Report, Oregon Fish and Shellfish Consumption Rate Project, Oregon Department of Environmental Quality, June 2008. Blank cells indicate data not available.

As shown in this table, the best available fish consumption data for high fish consumers in this region is generally consistent with findings in the national survey of the U.S. general population (EPA, 2002).

## Identifying a range for default fish consumption rates

In order to identify default fish consumption rates reasonably protective of high fish consumers, Ecology considered the data in the above table. Consistent with policies already used in MTCA cleanup decisions, the 90<sup>th</sup> to 95<sup>th</sup> fish consumption rate percentiles provide a range within which to identify a reasonable maximum exposure.

There are a number of ways to look at this data. Regional differences play a part in explaining the consumption differences among tribal survey data, as shown by abundant shellfish available to the Suquamish Tribe. Ecology recognizes that there are various options for identifying a range within which to establish default rates, including considerations of geographic distinctions. That is, the high fish consumption rate for the Suquamish Tribe may be overly conservative for parts of the state without the potential for shellfish habitat.

**Table 2. Various Options for Identifying an Appropriate Range Within Which to Establish a Default Fish Consumption Rate (or Rates)**

Fish Consumption Rate Range based on 90 <sup>th</sup> – 95 <sup>th</sup> percentile consumption (grams per day)		
	90 <sup>th</sup>	95 <sup>th</sup>

<i>Averages based on all 5 state surveys and the national data</i>	244	350
<i>Averages based on state survey data only</i>	243	253
<i>Recognize geographic distinctions in the state data and include national data (averages exclude Suquamish data)</i>	195	261
<i>Recognize geographic distinctions in the state data; use state survey data only (averages exclude Suquamish and national data)</i>	182	243
<i>Identify the range broadly to include all regional data, without averaging upper percentiles</i>	113	489 <sup>2</sup>

**Commented [MH1]:** Work in progress. See Chapter 7.

## Site-specific fish consumption rates

Ecology largely bases cleanup decisions on preventing health risks associated with the consumption of contaminated fish and shellfish. Default parameters may have to be adjusted to account for specific needs related to specific cleanup sites.

Cleanup standards are based on estimates of the reasonable maximum, so Ecology may establish more protective cleanup levels when default exposure parameters do not adequately protect the fish-consuming population in question. This allows for consideration of exposure parameters tailored to a specific fish-eating population within a particular watershed or water body.

It's important to consider certain environmental factors when developing a site-specific fish consumption rate, including:

- Fish species and life history.
- Historical information on habitat quality, abundance, and density.
- Toxic contamination of habitat and resultant fish tissue concentrations.
- Characteristics of the water body.

## Preliminary recommendation

Ecology believes that a default fish consumption rate (or rates) for use in Washington cleanup decisions should be protective of high fish consumers. High fish consumers include Native Americans, Asian and Pacific Islanders, and some recreational fishers.

Ecology concludes that a default fish consumption rate (or rates) between should be consistent with current scientific information and risk-management policies reflected in current state and federal rules and regulatory policies.

The selection of one or more default fish consumption rates from within a range is primarily a regulatory policy choice. Ecology believes that this choice needs to be made in concert with decisions on several other issues.

- What exposure scenarios should be considered?

<sup>2</sup> The upper 95<sup>th</sup> percentile fish consumption rate for the Suquamish data is 797 g/day. This data is not included in the Oregon Human Health Focus Group report.

- What other exposure parameters should be considered?
- How should Ecology take into account variability in fish consumption rates among individuals and geographic areas?
- How should Ecology take into account both the consumption and the life cycle of salmon when making regulatory decisions?
- What acceptable risk levels are being used when making regulatory decisions on cleanup standards and water quality standards?
- How do final recommendations compare with Washington rules and policies, federal guidance, and approaches used by other state, federal, and tribal environmental agencies?

## Conclusion

A default fish consumption rate should be reasonably protective and technically defensible for use in regulatory decisions, even though Washington has a diverse population with a wide range of fish-consuming patterns and habits. There are multiple ways to interpret the data presented in this Technical Support Document, and we believe that default fish consumption rates within these ranges are reasonable and protective of Washington fish consumers.

Ecology believes these ranges are technically defensible and should be used to establish sediment cleanup standards under the SMS rule, surface water cleanup standards under the MTCA rule, and water quality standards under the WQS rule.

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# Chapter 1: Introduction and Purpose

## Introduction

This report contains information related to fish consumption in Washington. The Washington Department of Ecology (Ecology) will use this information to decide whether to revise state requirements and, if so, how to update them.

Ecology currently uses two different fish consumption rates to establish regulatory requirements:

- 54 grams/day (g/day), included in the MTCA Cleanup Regulation as a default rate; this rate was established in 1991 using information from recreational anglers.
- 6.5 grams/day, included in water quality criteria for human health, issued by the U.S. Environmental Protection Agency (EPA) to Washington in 1992 (National Toxics Rule).

The methodologies used by these two approaches differ in a number of exposure assumptions.

Numerous scientific and regulatory developments have been made over the past 20 years regarding statewide default fish consumption rates. Ecology will be evaluating these developments to help determine if there is an appropriate default fish consumption rate that will be useful in regulatory decision making, given:

- Current data on fish consumption rates for different Washington population groups.
- Uncertainty and variability in rates for those populations as well as individuals in those groups.
- Current and potential future exposures from fish and shellfish consumption.
- Variability in the types of fish consumed.
- State laws and policies (including MTCA and the Water Pollution Control Act).
- Treaty-reserved fishing rights.
- Approaches used by other state and federal agencies.

Over the next several years, Ecology will be considering changes to several environmental regulations. These include the Sediment Management Standards (SMS) rule, the Water Quality Standards for Surface Waters (WQS), and the Model Toxics Control Act (MTCA) Cleanup Regulation. Ecology anticipates that the SMS rule will be revised first. As part of the process, Ecology will review various policy, technical, and scientific issues.

This report provides a summary, evaluation, and analysis of the technical, regulatory, and scientific information being considered by Ecology.



## Intended audience

Ecology intends to use this document to engage multiple audiences in discussions on issues related to deriving a statewide default fish consumption rate. This report is meant to facilitate discussions with the following interested parties:

- Pacific Northwest Native American tribal representatives and tribal organizations. Ecology respectfully acknowledges the importance of this topic for Washington tribes.
- Ecology's Sediment Cleanup Advisory Committee (to consist of members from the MTCA/SMS Advisory Group and Sediment Workgroup, expected to begin meeting in late summer or early fall 2011).
- Federal and state agencies (for example, EPA, Washington Department of Health, Washington Department of Fish and Wildlife).
- Cleanup action and water quality standards and permitting stakeholders and stakeholder groups, including local governments and ports, water quality advocates and Washington businesses.
- Other interested persons.

## Purpose of this document

Again, this report was prepared to support discussions regarding a fish consumption rate (or rates) appropriate for use as a default value in a regulatory context. Ecology plans to use this document to support discussions on a number of questions, including:

- What is the status of resources pertaining to the harvest of fish and shellfish in Washington?
- How many people in Washington consume fish? How many people in Washington can be considered high fish consumers?
- What are scientifically defensible methods for characterizing fish consumption rates?
- What is currently known about the fish consumption habits and rates for different fish-consuming populations in Washington?
- What are the current statutes, regulations, and policies that guide cleanup and source control decisions in Washington?
- Would establishing a statewide default fish consumption rate (or rates) be a useful step toward consistency among regulatory programs (for example, MTCA cleanups and water quality-based permitting)?
- What is an appropriate statewide default fish consumption rate (or rates) given available data, uncertainties and variability in fish consumption habits, and current statutes, regulations, and policies?

This report describes and documents information reviewed by Ecology, as well as the process used by Ecology in developing preliminary recommendations. The report also identifies factors

considered in evaluating fish consumption survey results. The approach described in this report is also applicable and appropriate for evaluating data related to site-specific evaluations.

The discussions and data presentations in this report are largely modeled on work done in Oregon. In particular, Ecology relied heavily on work by the Oregon Department of Environmental Quality Fish Consumption Rate Review Project, especially the Human Health Focus Group Report, published in June 2008.<sup>3</sup>

In preparing this document Ecology benefited from input by numerous knowledgeable persons and organizations, including:

- MTCA Science Panel<sup>4</sup>.
- Pacific Northwest Native American tribal representatives and tribal organizations (dialog is in progress and continuing).
- Oregon Department of Environmental Quality. (Ecology acknowledges and appreciates input from individuals involved with Oregon's Fish and Shellfish Consumption Rate Project.)
- Representatives from the University of Washington Department of Environmental and Occupational Health Sciences.
- U.S. Environmental Protection Agency, Region 10.
- Washington Department of Health.
- Washington Office of Financial Management.

Ecology recognizes that the topic of fish consumption rates is a broad topic and that the treatment in this report is not exhaustive. It is our hope that this document encourages interested and knowledgeable persons to provide input and contribute to an ongoing statewide discourse.

## Organization of this document

This document is organized as follows.

### *Chapter 2 – Washington Fish Resources and Fish-Consuming Populations*

Available information indicates that Washington residents consume some amount of local fish or shellfish. In addition, several population subgroups (including Native Americans, Asian and Pacific Islanders, and subsistence fishers) consume large amounts of fish and shellfish. This chapter summarizes available information on state water resources that support fishing practices. Regional differences are acknowledged and the size and demographic characteristics of Washington fish and shellfish consumers and consuming populations are identified.

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<sup>3</sup> Oregon Department of Environmental Quality, Human Health Focus Group Report– Oregon Fish and Shellfish Consumption Rate Project Report, June 2008.

<sup>4</sup> The MTCA Science Advisory Board was dissolved by the legislature in 2009. Ecology currently receives scientific advice on cleanup matters by a panel of scientists.

### *Chapter 3 – Methodology for Assessing Fish Consumption Rate Information*

Several approaches are available for developing estimates of fish and shellfish consumption. Although surveys are generally considered to be the best approach for developing these estimates, a number of design features determine whether a particular survey provides a technically defensible basis for agency decision-making. This chapter reviews those design features and outlines the factors considered when evaluating studies.

### *Chapter 4 – Fish Consumption Survey Data Applicable to Washington Fish Consumers*

Over the last several years, Ecology and other agencies have evaluated and used available fish consumption surveys in the context of site-specific regulatory decisions. The purpose of this chapter is to (a) identify these evaluations and summarize the fish consumption rates derived from each survey and (b) provide an initial determination as to which studies Ecology believes should be used in identifying an appropriate default fish consumption rate or rates.

### *Chapter 5 – Regulatory Context for Using Fish Consumption Rates*

Ecology currently establishes water quality standards, surface water cleanup standards, and sediment cleanup standards based on protecting human health according to the Model Toxics Control Act and the Water Pollution Control Act. The fish consumption rate can make a significant difference in the stringency of those requirements. The choice of a default fish consumption rate for use throughout Washington leads to questions about the scientific information and policies within the laws and regulations. This chapter summarizes the Washington regulatory framework.

### *Chapter 6 – Site-Specific Fish Consumption Rates*

Using a default fish consumption rate may not be appropriate in all situations. Cleanup is about removing health risks associated with the consumption of contaminated fish and shellfish. Exposure parameters used in setting cleanup levels, including the fish consumption rate, may need adjusting to account for site-specific needs. This chapter identifies elements appropriate to consider in setting (for cleanup purposes) a site-specific fish consumption rate protective of human health.

### *Chapter 7 – Recommendations*

Over the next several years, Ecology will be considering revisions to the SMS rule, the Water Quality Standards for Surface Waters, and the MTCA Cleanup Regulation. This chapter reviews options Ecology considered and provides the rationale behind the recommendation that the default rate or rates be within an identified range. Ecology views this preliminary recommendation as a starting point for discussions. Subsequent proposals for rule revision will be evaluated according to regulatory analyses required under the Washington Administrative Procedures Act and the State Environmental Protection Act.

### *Appendices*

Included here are tables that summarize fish consumption survey information, other fish consumption information used for regulatory decision making, fish species found in Washington, information on Washington tribes, a description of the EPA Region 10 decision framework, a glossary of terms, and references.

## Chapter 2: Washington Fish Resources and Fish-Consuming Populations

### Introduction

Washington is home to a wide range of water resources that support commercial, recreational, and subsistence fishing. Most Washington residents consume some local fish or shellfish. Several population groups consume larger amounts of fish and shellfish than the general population. These include members of Native American tribal nations, Asian and Pacific Islanders, and subsistence fishers.

This chapter is organized into the following sections:

- *Fish Resources.* A summary of fish and shellfish resources in Washington.
- *Washington's Population Demographics.* A summary of current demographic information.
- *Estimated Number of Washington Fish Consumers.* This section provides estimates on the number of adults and children in Washington who regularly eat fish and/or shellfish.
- *High Fish-Consuming Populations.* This section provides a definition of “high fish consumers” and identifies and describes subpopulations in Washington generally know to be high fish consumers.

### Washington's significant fish resources

Washington waters support large finfish and shellfish populations and both commercial and recreational harvests.

Ecology reviewed available data on commercial and recreational fish harvests. In summary, commercial fish harvests are associated with a multispecies fishery including groundfish, Pacific halibut, coastal pelagic species, highly migratory species, salmon, other anadromous species and eggs, and shellfish. Similarly, recreational sport fishing is structured around a multispecies fishery and hundreds of thousands of sport anglers harvest fish throughout Washington.

According to the Washington Department of Fish and Wildlife (2008), the following amounts were harvested in 2006:

- Over 100 million pounds of finfish and shellfish. Salmon represented about 10 percent of the commercial catch (over 11 million pounds)
- Close to 8 million pounds of shellfish (Dungeness crab, shrimp, razor clams, and other types of clams)

- Over 650,000 oysters
- Over 3 million pounds each of Dungeness crab and razor clams, accounting for approximately 50 percent of the recreational shellfish harvest

Salmon are of particular importance in Washington, and questions about Salmon are discussed at several points in this document. Salmon are harvested in from freshwaters and marine waters. The Puget Sound area streams and the Columbia River basin dominate the areas of harvest. Steelhead and salmon (from both marine and freshwater) account for about half of the recreational sport harvest (close to 400,000 fish) in 2006.

## Washington fish resources

Washington has more than 500 miles of Pacific coast shoreline and over 2,000 combined miles of Puget Sound, San Juan Islands, Strait of Juan de Fuca, and Hood Canal shoreline. This shoreline provides habitat for marine fish and shellfish. In addition, the state has 4,000 rivers and streams, stretching over 50,000 miles. Many streams and rivers have seasonal salmon and steelhead runs. State waters also include more than 7,000 lakes, with over 2,500 lakes at alpine elevations, and more than 200 reservoirs that provide additional fishing opportunities. Many freshwater areas are open for fishing year-round.<sup>5</sup>

A large variety of fish and shellfish are available for harvesting in Washington.<sup>6</sup> The Washington Department of Fish and Wildlife (WDFW) has identified more than 50 species of edible freshwater fish and almost as many in marine waters.<sup>7</sup> (See Appendix B for information on fish and shellfish species harvested in Washington.)

Governor Gregoire requested a study to summarize the economic benefits of Washington's nontreaty commercial and recreational fisheries for 2006.<sup>8</sup> This study provides information on the valuation and numbers of commercial and recreational fish and shellfish harvested throughout Washington. In 2006, commercial fish landings from nontreaty fisheries totaled more than 109 million pounds. The Washington coastal area is the largest contributor to commercial fish harvesting, accounting for 85 percent of total pounds landed.<sup>9</sup>

## Salmon in Washington

The salmon industry is significant both culturally and economically in Washington. The people of the state have invested considerable resources in restoring and protecting the rivers and

<sup>5</sup> 2010 Washington Fishing Prospects. Where to Catch Fish in The Evergreen State. Washington Department of Fish and Wildlife. Web location: <http://www.wdfw.wa.gov/fish/prospects/index.htm>

<sup>6</sup> IBID, pages 17 to 30.

<sup>7</sup> IBID, pages 17 to 30.

<sup>9</sup>Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State. Final Report. Washington Department of Fish and Wildlife. December 2008. Web location: [http://wdfw.wa.gov/commission/econ\\_analysis.html](http://wdfw.wa.gov/commission/econ_analysis.html)

streams that provide spawning grounds for salmon, along with the nearshore habitat for growing juvenile salmon and sheltering returning adults.<sup>10</sup>

WDFW and wildlife and tribal fisheries managers co-manage fish resources in Washington. Every year, state, federal, and tribal fishery managers meet to plan the Pacific Northwest's recreational and commercial salmon fisheries and harvests. The preseason harvest planning process is generally referred to as the "North of Falcon" process. This process coincides with the March and April meetings of the Pacific Fishery Management Council (PFMC), the federal authority responsible for the ocean salmon season 3 to 200 miles off the Pacific coast. In addition to the PFMC meetings, Washington and Oregon and the treaty tribes sponsor additional meetings to discuss alternative fishing seasons that meet conservation and allocation objectives.

These meetings require pre-season forecasts for wild and hatchery run sizes for all salmon species throughout Washington. For example, the 2010 pre-season forecast for summer and fall Chinook in Puget Sound is:

- For the lower south sound, total over 111,000.
- For the north sound, total over 66,700.
- For the upper south sound, total over 53,000.

Similar data is available for Chinook in other locations of Washington and for coho, chum, pink, and sockeye salmon.<sup>11</sup>

Salmon consumption is not included in many CERLA risk assessments. This is based on assumptions that salmon contaminant body burdens mostly come from the open ocean waters and are not attributable to site-specific contaminants.<sup>12</sup> Ecology believes, however, that despite the complexity of the salmon life history there are reasons to include salmon in considerations of default fish consumption rates:

- The life cycle and life history of salmon results in recycling the contaminant body burden to future generations of salmon
- Salmon are harvested from marine/estuarine waters and freshwaters throughout Washington
- Salmon are consumed by all Washington fish consuming populations
- Some salmon (the "resident" populations) never leave Puget Sound and are harvested and consumed after spending their entire adult life in Puget Sound waters
- Some salmon species migrate out of Puget Sound but remain along the Pacific continental shelf

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<sup>10</sup> A large percentage of salmon migrate to the ocean where they spend their adult years, and Ecology recognizes uncertainty around how to quantify risk associated with eating salmon. [See also Chapter YYY.](#)

<sup>11</sup> North of Falcon Q & A. Washington Department of Fish and Wildlife. Web location: <http://wdfw.wa.gov/fish/northfalcon/faq.htm>

<sup>12</sup> Lower Duwamish Waterway Remedial Investigation. Appendix B: Baseline Human Health Risk Assessment, Final. November 12, 2007.

- For persistent, bioaccumulative, and toxic chemicals with a global distribution (PCBs and methylmercury) no unique chemical signature associates salmon contaminant body burden with site-specific contaminants

(See Appendix E for more information on salmon in Washington and a discussion of including salmon in fish consumption rates.)

## Washington's commercial fishery

Washington's commercial fishery is structured around a multispecies fishery including groundfish, Pacific Halibut, coastal pelagic species, highly migratory species, salmon, other anadromous species and eggs, and shellfish. In 2006, nontribal commercial fish landings from Washington fisheries totaled approximately 109.4 million pounds.

In 2006, groundfish (bottom-dwelling fish) composed the state's largest commercial fishery. Groundfish accounted for 54 percent of the commercial catch from Washington waters, with approximately 59.2 million pounds landed. Shellfish landings represented the state's second-largest, commercial fishery accounting for almost 25 percent of the commercial catch, with approximately 25.8 million pounds landed in 2006.

Salmon is a major contributor to Washington's commercial fishing industry. Salmon landings from Washington waters totaled about 11 million pounds, accounting for about 10 percent of the commercial catch in 2006.

Table 3 illustrates the extent of Washington's commercial fishery, showing pounds of fish harvested from Washington nontreaty fisheries in 2006. (Refer to Appendix B for additional information.)

**Table 3. Commercial Fish Landings From Washington Nontreaty Fisheries in 2006**

Species	Pounds Landed
Groundfish (excluding halibut)	59,217,924
Total shellfish	25,789,641
Salmon	11,020,228
Coastal pelagic species	8,233,078
Highly migratory species	4,802,666
Other anadromous fish and eggs	158,621
Pacific halibut	135,868
Total commercial pounds landed of finfish/shellfish	109,358,026

*Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State. Final Report. Washington Department of Fish and Wildlife. December 2008. Adapted from Table 1, page 6.*

## Washington's recreational fishery

Traditionally, Washington's most intense freshwater fishing starts the last weekend in April. Based on estimates from WDFW, over 300,000 anglers fish on opening weekend of fishing season. To meet this demand, WDFW stocks about 19 million trout and kokanee fry annually. Another 3 million catchable trout are planted in lakes and streams. In addition, many lakes

receive additional sterile triploid rainbow trout. Most rivers and streams throughout Washington are managed to produce wild trout, coastal and westslope cutthroat, salmon, and steelhead.<sup>13,14</sup>

An estimated total of 824,000 anglers fished (both finfishing and shellfishing) in Washington in 2006. An estimated 725,000 anglers (88 percent of the total) were state residents who fished about 8.5 million days that year. This amount equals 93 percent of all fishing days available for licensed recreational sport fishing.<sup>15</sup>

Marine recreational fishing and shellfishing occurs along more than 500 miles of the Pacific Coast shoreline and more than 2,000 combined miles of shoreline throughout Puget Sound, San Juan Islands, Strait of Juan de Fuca, and Hood Canal.<sup>16</sup> As previously noted, freshwater recreational fish inhabit more than 4,000 rivers and streams extending over 50,000 miles, 7,000 lakes, and 200 reservoirs.<sup>17</sup> The following are selected highlights of recreational sport fishing and shellfishing that identify the quantity of species available for recreational anglers across Washington:

- Recreational fishing for smelt (eulachon) on the Columbia River and its tributaries and smelt fishing along Washington's north coast and Puget Sound fisheries
- Recreational fishing for shad on the Columbia River with several million shad passing through Bonneville Dam annually
- Recreational sturgeon fishing on the Columbia River
- Marine recreational seasonal fishing for lingcod, halibut, and rockfish as well as other marine bottomfish are available year-round
- Recreational shellfishing for oysters, clams, shrimp, and crab available throughout Puget Sound, Hood Canal, San Juan Islands, and the Strait of Juan de Fuca

Recreational sport anglers harvest finfish in marine and fresh waters and shellfish along marine shorelines. Approximately 22 million trout and kokanee are stocked annually in lakes and inland streams and are available to recreational anglers. Table 4 and Table 5 list information on the 2006 sport finfish and shellfish harvests, respectively. These numbers demonstrate the extent of recreational fishing in Washington.

Approximately two-thirds of the 2006 catch for bottomfish were harvested in coastal waters, with the remaining one-third harvested from the marine waters of Puget Sound. Approximately 74 percent of the steelhead and 95 percent of the sturgeon harvested from Washington waters in 2006 were from the Columbia River and its tributaries.

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<sup>13</sup> Washington Department of Fish and Wildlife. Washington Fish Prospects. Web location: <http://www.wdfw.wa.gov/fish/prospects/index.htm>

<sup>14</sup> Washington Department of Fish and Wildlife. 2010 Washington Fishing Prospects. Where to Catch Fish In The Evergreen State. Web location: <http://www.wdfw.wa.gov/fish/prospects/index.htm>

<sup>15</sup> Washington Department of Fish and Wildlife. Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State. December 2008

<sup>16</sup> IBID

<sup>17</sup> Washington Department of Fish and Wildlife. 2010 Washington Fishing Prospects. Where to Catch Fish In The Evergreen State. Web location: <http://www.wdfw.wa.gov/fish/prospects/index.htm>



Salmon were harvested in both fresh and marine waters, with approximately 60 percent of the salmon harvest occurring in marine waters. Puget Sound salmon accounted for approximately 60 percent of all salmon harvested in marine waters. In fresh waters, approximately 57 percent of the salmon are harvested in Puget Sound streams, and 38 percent are from the Columbia River and its tributaries.

Dungeness crab taken from north Puget Sound waters accounted for more than 85 percent of the 2006 statewide harvest. Razor clams are only harvested from coastal beaches. Tens of thousands of recreational sport clammers harvest razor clams on weekends when razor clamming season is open along coastal beaches.<sup>18</sup>

**Table 4. Number of Recreational Finfish Caught in Washington Waters in 2006 by Species and Region<sup>19</sup>**

Species/Group	Catch Region				Total
	Puget Sound	Coast	Columbia River <sup>20</sup>	Unknown	
Bottomfish	112,457	295,151	---	---	407,608
Salmon – fresh waters	98,576	7,186	65,817	1,227	172,806
Steelhead	12,709	15,415	80,294	477	108,895
Salmon – marine	65,423	43,027	---	---	108,450
Albacore	---	18,941	---	---	18,941
Sturgeon	203	456	15,695	182	16,536
Pacific halibut	2,727	6,977	692	---	10,400
Total	292,095	387,153	162,498	1,886	843,636

**Table 5. Pounds of Shellfish Taken from Washington Waters in 2006 by Species and Region<sup>21</sup>**

Species/Group	Catch Region					Totals
	North Puget Sound	South Puget Sound	Strait	Coast	Columbia River	
Dungeness crab	3,330,004	271,167	261,540	---	---	3,862,711
Razor clams	---	---	---	3,601,000	---	3,601,000
Oysters	19,129	632,966	---	---	---	652,095
Other clams	93,038	252,628	---	---	---	345,666
Shrimp	23,520	87,996	1950	---	---	113,466

<sup>18</sup> Washington Department of Fish and Wildlife. Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State. December 2008

<sup>19</sup> Ibid. Adapted from Table 6, page 17.

<sup>20</sup> Columbia River region includes the Columbia Rivers and all tributaries and the Snake River

<sup>21</sup> Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State. Final Report. Washington Department of Fish and Wildlife. December 2008. Adapted from Table 7, page 17. All values are in pounds except oysters which are in number of oysters harvested.

## Washington population demographics

Washington is home to a cultural and ethnically diverse population that is projected to become more diversified over the next 20 years. The Washington Office of Financial Management (OFM) provides the following demographic information.<sup>22</sup>

Total Washington Population as of April 1, 2010 <sup>23</sup>	6,724,540
Adults (74% of the population is estimated at over 18) <sup>24</sup>	5,143,186
Children (between 0 and 18 years of age) <sup>25</sup>	1,708,318

OFM projects that the Washington population will increase by 1.8 million people in the next 20 years.

Projected Total Washington Population, 2030 <sup>26</sup>	8,544,700
Projected Children (between 0 and 18 years of age) 2030	2,063,883

## Estimated fish consumers in Washington

Information about how much fish from Washington waters is consumed by the general Washington population is available only through estimates. In order to estimate the number of fish consumers in Washington and how much fish is consumed, Ecology considered multiple approaches. First, the total number of fish consumers is estimated. Then, a definition of “high fish consumer” is used to suggest the number of people in the general population at the high end of the exposure distribution. These estimates provide a rough estimate of the number of fish consumers, but limited information about where the fish is from. Ecology also looked at information about certain ethnic groups in Washington known to consume fish from local waters. The purpose of these estimates, together with the information about the commercial and recreational fisheries, is to identify the importance of fish and fish consumption in Washington.

Ecology estimated the total number of fish consumers in Washington using two distinct methods. The two approaches (described below) provide a lower and upper estimate.

Using 2010 demographic information provided by the Washington OFM, Ecology estimates that between 1.4 and 3.8 million Washington adults (and approximately 290,000 Washington children 0 to 18 years old) are fish consumers. The range of adult consumers was established as follows:

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<sup>22</sup> U.S. Census Bureau, Census 2000 Redistricting Data (Public Law 94-171) Summary file, Table PL1, and 2010 Census Redistricting Data (Public Law 94-171) Summary file, Table P1. [Provided by Washington State's Office of Financial Management At <http://www.ofm.wa.gov/pop/census2010/data.asp>]

- *Estimate I: Based on National Survey Data.* The first approach resulted in the lower of the two estimates. It was developed using Washington population data and information on the percentage of fish consumers reported in the EPA 2002 publication *Estimated Per Capita Fish Consumption in the United States*. For this estimate, Ecology assumed Washington dietary habits are similar to those for the United States as a whole. The Oregon DEQ's Human Health Focus Group used this approach to prepare estimates of fish consumers in Oregon. (See Chapter 4 for additional information on the EPA national fish consumption estimates.)
  - *Adults.* EPA found that 28 percent of the adults interviewed in the national survey were fish consumers.<sup>27</sup> Assuming that a similar percentage of Washington's 5,143,186 adults also consume fish, Ecology estimates that approximately 1,440,092 adults in Washington currently eat some amount of fish.
  - *Children.* EPA found that 16 to 19 percent of children (ages 0 to 18) included in the national survey were fish consumers.<sup>28</sup> Assuming that 17 percent of Washington's 1,708,318 children also consume fish, Ecology estimates that there are approximately 290,000 children in Washington who currently eat some amount of fish.
- *Estimate II: Based on Washington Department of Health Survey.* The second approach resulted in the higher estimate. It was developed using Washington population data and information compiled by the Washington Department of Health (DOH). DOH used the Behavioral Risk Factor Surveillance System (BRFSS) to compile information on fish consumption habits of randomly selected Washington residents.<sup>29</sup> This work was done over a 4-year period; it was designed to improve DOH's understanding what percent of the population consume fish in Washington.
  - DOH found that in 2002 and 2004, 78 percent and 74 percent, respectively, of adults in Washington consumed store-bought fish. In 2005, 57 percent of the adults surveyed reported eating fresh fish purchased at a local grocery store or fish market (frozen fish excluded). Among Washington fish consumers, 44 percent consumed salmon, 20 percent consumed halibut, 13 percent consumed cod, and 6 percent consumed tuna.
  - Although this data was intended for use by DOH in developing fish consumption advisory programs, Ecology, after consultation with DOH, determined that the information is appropriate for estimating the total number of fish consumers in Washington as needed for this report.
  - Working with DOH, Ecology estimated that between 2.9 and 3.8 million Washington adults currently consume some amount of fish and/or shellfish. Table 6 provides estimates of Washington fish consumers calculated by Ecology using the DOH data.

<sup>27</sup> U.S. Environmental Protection Agency Estimated Per Capita Fish Consumption in the United States. EPA-821-C-02-003. August 2002. Table 4, Section 5.1.1.1.

<sup>28</sup> Jacqueline Moya (US EPA ) Personal communication with Craig McCormack (Ecology), April 11, 2011. Approximately 18% of the US general population ages 16 – 21 are fish consumers; approximately 31% of the US general population ages 20 – 50 are fish consumers. Information based on EPA's reexamination of the National Health and Nutrition Examination Survey (NHANES) and the 2002 per capita fish consumption report.

<sup>29</sup> The BRFSS is sponsored by the U.S. Centers for Disease Control and Prevention (CDC) and is a probability-based telephone survey of non-institutionalized adults, ages 18 years and over.

**Table 6. Estimated Washington Fish Consumers Based on Washington DOH Survey Data**

Years for Projected Population Estimates	Estimated number of Washington adults who consume:		
	Store-bought fish	Fish from local stores or markets	Salmon
2010	3,805,958 <sup>30</sup>	2,931,616 <sup>31</sup>	1,674,622
2030	4,876,809	3,756,461	2,899,725

Commented [MH2]: Confirm numbers

Population projections are included to illustrate that estimates of total numbers of fish consumers in Washington are expected to increase as the population grows.

### Estimated number of high fish consumers

For purposes of this report, *high fish consumers* are persons who consume fish at or above the 90<sup>th</sup> national per capita percentile fish, as reported in the U.S. EPA 2002 publication *Estimated Per Capita Fish Consumption in the United States*.

For adults, 250 g/day corresponds to the 90<sup>th</sup> percentile of the estimated national per capita fish consumption rate for adults. This value is used to define high fish-consuming adults. For children, 190 g/day corresponds to the 90<sup>th</sup> percentile of the estimated national per capita fish consumption rate for children. This value is used to define high fish-consuming children.

Ecology estimates that between 146,000 and 384,000 Washington adults are high fish consumers. Based on OFM population projections, this number could increase by 27 percent over the next 20 years.

This estimate is based on a number of assumptions:

- It is reasonable to assume that between 1,440,000 and 3,806,000 Washington adults consume some amount of fish on a regular basis. As described in the previous sections, this range is based on current population data and estimates indicating that between 28 and 74 percent of Washington adults regularly consume fish.
- It is reasonable to define “high fish consumers” as people (adults) who consume more than 250 grams of fish and/or shellfish per day. This value represents the 90<sup>th</sup> percentile fish consumption rate reported in the national consumption survey conducted by EPA in 2002. In other words, EPA found that 90 percent of the people who reported that they ate fish or shellfish reported that they ate less than 250 g/day, while 10 percent reported that they ate more than 250 g/day.
- It is reasonable to assume that the dietary habits and patterns for Washington fish consumers are similar to those reported for the United States fish consumers.<sup>32</sup>

<sup>30</sup>This estimate assumes 74% of the total adult population consuming store-bought fish, per the DOH 2004 data.

<sup>31</sup> This estimate assumes 57% of the total adult population consuming fresh fish from local stores or markets, per the DOH 2005 data.

<sup>32</sup> This assumption is discussed further in the conclusions to this chapter.

**Table 7. Estimates of Fish Consumption among the Washington Adult Population**

Year	Total Population (Adults)	Estimates of All Washington Adult Fish Consumers		Estimates of Washington Adult High Fish Consumers (over 250 g/day)	
		Low (28%)	High (74%)	Low	High
2010	5,143,185	1,440,092	3,805,958	144,009	380,596
2030	6,590,283	1,845,279	4,876,809	184,528	487,680

For the purposes of this report, Ecology estimates the range of high fish-consuming adults in Washington as between 144,000 and 381,000.

### Estimated number of high fish-consuming children

For purposes of this report, Ecology defines as “high fish consumers” children who consume fish at or above the 90<sup>th</sup> percentile of the estimated national per capita fish consumption rate for children as reported in the U.S. EPA 2002 publication *Estimated Per Capita Fish Consumption in the United States*. This value, 190 g/day, is used to define high fish-consuming children.

Ecology estimates that there are approximately 29,000 Washington children who are high fish consumers. Based on OFM population projections, this number could increase by 83 percent over the next 20 years. This estimate is based on the following assumptions:

- It is reasonable to assume that approximately 290,000 Washington children eat some amount of fish on a regular basis. As discussed in an earlier section, this estimate is based on current population estimates and national survey results that indicate that 16 to 19 percent of children reported eating some amount of fish or shellfish.
- It is reasonable to define “high fish consumers” as children who consume more than 190 grams of fish and/or shellfish per day. This value represents the 90<sup>th</sup> percentile fish consumption rate for children reported in the national consumption survey conducted by EPA in 2002.<sup>33</sup> In other words, EPA found that 10 percent of the children who reported that they ate fish or shellfish reported that they ate more than 190 g/day.
- It is reasonable to assume that the dietary habits and patterns for Washington fish consumers are similar to those reported for the United States fish consumers.

**Table 8. Estimated Number of Washington Children High Fish Consumers (Children Younger Than 18 Years Consuming Large Amounts of Fish or Shellfish)**

Year	Total Population of Children (18 and younger)	Estimated Number of Children Who Consume Some Amount of Fish and Shellfish	High Fish Consumers: Estimated Number of Children who Consume over 190 g/day
2010	1,708,318	290,000	29,000
2030	2,063,883	351,000	35,100

<sup>33</sup> U.S. Environmental Protection Agency, 2002. Estimated per Capita Fish Consumption in the United States. EPA-821-C-02-003, Section 5.2.1.1, Table 4.

## Discussion

A number of observations are pertinent to estimates of both adult and children's fish consumption. Moya (2004) reports that people living in coastal states tend to consume fish and shellfish at a higher frequency and at higher rates than people living in inland states.<sup>34</sup> This suggests that the distribution of fish consumption rates (including the 90<sup>th</sup> percentile value) may be higher in Washington than a distribution based on national survey statistics.

Ecology also notes that the estimates in this chapter may under estimate the number of children who consume large amounts of fish both because the estimates rely on national survey data and they do not take into account ethnic differences in fish consumption rates. (See Appendix B for information on child exposure and susceptibility.)

The estimated number of high fish consumers in Washington would be higher if lower rates were used to define high fish consumers. The median adult fish consumption rate for the U.S. population of fish consumers is approximately 100 grams/day. This is higher than the current default fish consumption rates (6.5 and 54 g/day) used in Washington by Ecology in a regulatory context. Ecology estimates that there are between 730,000 and 1,920,000 Washington adults who consume more than 100 g/day.

## High fish-consuming populations

Some population groups consume especially large amounts of fish and shellfish as part of traditionally influenced diets. These include Asian and Pacific Islanders and Native Americans.

### Asian and Pacific Islanders

Asian and Pacific Islander (API) populations include Native Hawaiians and peoples from other Pacific islands. The Washington OFM estimates there are approximately 521,542 Asian and Pacific Islanders currently residing in Washington.<sup>35</sup> Fish and shellfish consumption among this population in Washington has been documented.<sup>36</sup> Approximately 75 percent of the current API population is 18 years of age or older (405,158 adults).<sup>37</sup> There are 137,917 Asian and Pacific Islanders between the ages of 0–18 years.<sup>38</sup>

OFM projects that the total number of Asian and Pacific Islanders in Washington will increase from 521,542 in 2010 to approximately 825,000 by the year 2030.<sup>39</sup>

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<sup>34</sup> Jacqueline Moya. Overview of Fish Consumption Rates in the United States. Human and Ecological Risk Assessment, 10: 1195-1211, 2004.

<sup>35</sup> U.S. Census Bureau, Census 2000 Redistricting Data (Public Law 94-171) Summary file, Table PL1, and 2010 Census Redistricting Data (Public Law 94-171) Summary file, Table P1. [Provided by Washington State's Office of Financial Management At <http://www.ofm.wa.gov/pop/census2010/data.asp>] Table 2

<sup>36</sup> Sechena, R., Nakano, C., Liao, S., Polissar, N., Lorenzana, R., Truong, S., Fenske, R., 1999. Asian and Pacific Islander Seafood Consumption Study in King County, WA. U.S. Environmental Protection Agency, Region 10, Seattle, Washington, EPA/910/R-99-003.

<sup>37</sup> IBID

<sup>38</sup> 2010 population are based on the 2010 Census release of Redistricting data. 2030 estimates are as of OFM 2006 Population Projections by Age, Sex, and Race. Update is expected to be completed in summer 2012

<sup>39</sup> IBID

Population of Asian and Pacific Islanders in Washington	521,542
Adults (75% of the population is estimated at over 18) <sup>40</sup>	405,158
Children (between 0 and 18 years of age) <sup>41</sup>	137,917
2030 API Population Projection <sup>42</sup>	825,000

## Washington Native American Tribes

Washington is home to 29 federally recognized and seven nonfederally recognized Native American tribes.<sup>43</sup> Traditional fishing areas for tribes cover essentially all of Washington. (See Chapter 1 Appendix A Appendix F.)

The Washington OFM estimates there are approximately 103,869 American Indian and Alaska natives in Washington.<sup>44</sup> Approximately 70 percent of the American Indian and Alaska native population is 18 years of age or older (73,523 adults).<sup>45</sup> OFM estimates there are 33,599 American Indian and Alaska natives between the ages of 0–18 years.<sup>46</sup>

OFM projects that the total number of Native Americans in Washington will increase from 103,869 in 2010 to approximately 146,000 by the year 2030.

Population of American Indian and Alaska natives in Washington	103,869
Adults (70% of the population is estimated at over 18) <sup>47</sup>	73,523
Children (between 0 and 18 years of age) <sup>48</sup>	33,599
2030 Population Projection <sup>49</sup>	146,000

## Subsistence fishers

Ecology recognizes that Washington is home to some number of persons engaged in a subsistence lifestyle. Considerations related to subsistence fishing for Native Americans tribes

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<sup>40</sup> IBID

<sup>41</sup> 2010 population are based on the 2010 Census release of Redistricting data. 2030 estimates are as of OFM 2006 Population Projections by Age, Sex, and Race. Update is expected to be completed in summer 2012

<sup>42</sup> IBID

<sup>43</sup> Governor's Office of Indian Affairs, July 2010 access to web link: Governors Office of Indian Affairs Doc's/Federally recognized WA Tribes & Maps.mht

<sup>44</sup> U.S. Census Bureau, Census 2000 Redistricting Data (Public Law 94-171) Summary file, Table PL1, and 2010 Census Redistricting Data (Public Law 94-171) Summary file, Table P1. [Provided by Washington State's Office of Financial Management At <http://www.ofm.wa.gov/pop/census2010/data.asp>] Table 2

<sup>45</sup> IBID

<sup>46</sup> 2010 population are based on the 2010 Census release of Redistricting data. 2030 estimates are as of OFM 2006 Population Projections by Age, Sex, and Race. Update is expected to be completed in summer 2012

<sup>47</sup> IBID

<sup>48</sup> 2010 population are based on the 2010 Census release of Redistricting data. 2030 estimates are as of OFM 2006 Population Projections by Age, Sex, and Race. Update is expected to be completed in summer 2012

<sup>49</sup> IBID

in the Pacific Northwest have been identified.<sup>50</sup> However, due to a lack of data, at this time Ecology is unable to estimate the numbers subsistence fishers in Washington.

## Summary and conclusions

Current demographic information allows estimating the total number of Washington fish consumers

Ecology estimates that between 1.4 and 3.8 million Washington adults and approximately 290,000 children regularly consume fish.

Ecology reached this conclusion after working with OFM to use census data and applying national and Washington fish consumption rate estimates to the general Washington population. According to this Ecology analysis there are between 1.4 and 3.8 million Washington adults (18 years of age or older) who are fish consumers.<sup>51</sup> The number of adult fish consumers is projected to increase by up to 27 percent as Washington's population grows over the next 20 years.

Ecology estimates that approximately 290,000 Washington children (0 to 18 years of age) consume fish. This may underestimate Washington children fish consumers because it was developed using national survey data for the general population; studies have shown that people living in coastal states tend to consume fish and shellfish at a higher frequency and higher rates than inland states.<sup>52 53</sup> Ecology is not aware of Washington surveys that have examined child fish consumption frequency for the general population. The number of Washington children who eat some type of fish is also projected to increase as Washington's population grows over the next 20 years.

### Estimates of high fish consumers

For this report, Ecology defined "high fish consumers" as all Washington adults who consume more than 250 grams of fish and/or shellfish per day and all Washington children who consume more than 190 g/day. These values represent the 90<sup>th</sup> percentile fish consumption rates for adults and children reported in the national consumption survey conducted by EPA in 2002.

- Ecology estimates that there are between 146,000 and 384,000 Washington adults who are high fish consumers. Ecology believes that the high end of this range provides the best estimate of high fish consumers in Washington. The high-end of the range is based on

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<sup>50</sup> Donatuto and Harper, 2008. Jamie Donatuto and Barbara L. Harper. "Issues in Evaluating Fish Consumption Rates for Native American Tribes. Perspective." *Risk Analysis*, Vol. 28, No. 6, 2008, pages 1497-1506 and Harper B., Harris S. "A possible approach for setting a mercury risk-based action level based on tribal fish ingestion rates." *Environmental Research*, 107 (2008) 60-68.

<sup>51</sup> This includes a large number of recreational anglers. For example, the Washington Department of Fish and Wildlife estimates there were 824,000 recreational anglers (both fin-fishing and shell-fishing) in Washington in 2006.

<sup>52</sup> Moya, 2004. Jacqueline Moya. Overview of Fish Consumption Rates in the United States. Human and Ecological Risk Assessment, 10: 1195-1211, 2004.

<sup>53</sup> National fish consumption studies are typically carried out over a broad geographical area, including multiple states. Consequently, national studies may underestimate the rates and frequencies for states like Washington.



information collected by the Department of Health on fish consumption habits of Washington residents.

- Ecology estimates that there are approximately 29,000 Washington children who are high fish consumers.

Certain population groups, including Asian and Pacific Islanders and Native Americans, consume large amounts of fish and shellfish.<sup>54</sup>

- According to OFM estimates there are approximately 103,869 Native American and Alaska natives in Washington.
- According to OFM estimates there are approximately 521,542 Asian and Pacific Islanders in Washington.

Ecology concludes that Washington harvests for consumption considerable quantities of fish and shellfish both recreationally and commercially, and that Washington residents consume fish and shellfish with a significant amount likely coming from local sources. High fish consumers include several population groups known to consume larger amounts of fish and shellfish than the general population.

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<sup>54</sup> Chapter 4 discusses further the consumption rates, patterns and species consumed by Native Americans and Asian and Pacific Islanders.

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## Chapter 3: Methodology for Assessing Fish Consumption Rate Information

### Introduction

Researchers use a variety of methods for estimating the amount of fish and shellfish consumed. Surveys are generally considered to be the best approach for collecting data; however a number of design features determine whether a particular survey will provide a technically defensible basis for agency decision-making.

This chapter reviews the design features of various methods for collecting information about fish and shellfish consumption. The purpose of this review is to identify the specific factors that Ecology considered when evaluating fish consumption rate surveys.

With the analysis in this document Ecology is proposing to establish a range for statewide default fish consumption rates for use in certain regulatory decisions. In order to do this, Ecology has evaluated available data on fish consumption in Washington. To establish which studies are appropriate for the purposes of deriving a default fish consumption rate, Ecology has identified factors to consider in establishing the technical defensibility a particular survey.

This chapter is organized into three sections:

*Surveys and Other Approaches Used to Estimate Fish Consumption.* This section reviews the various mechanisms that have been used or are available for collecting data about dietary habits and patterns surrounding fish consumption.

*Factors to Consider when Evaluating Survey Results.* This section identifies key design or implementation features that impact the quality of individual surveys.

*Establishing Technical Defensibility.* This section sets out the methodology Ecology used in assessing the technical defensibility of fish consumption survey information and results. The methodology explained here is then applied in the next chapter to surveys pertinent to Washington.

## Surveys and other approaches used to estimate fish consumption

The various approaches to collecting information on fish/shellfish dietary habits and patterns include telephone surveys, mail surveys, food diaries, personal interviews, and creel surveys.<sup>55</sup> Each method has certain limitations, including bias, error, and variability.<sup>56,57</sup> Ecology conducted a thorough examination of the methodology used in fish consumption surveys. In order to determine quality and ensure utility for each survey examined, Ecology evaluated experimental design, target population, sample size, location, and potential bias.<sup>58</sup> We believe that this analysis aids general understanding and identifies the limitations and utility of the data available.

Fish dietary survey methodologies and limitations described in this report are consistent with EPA guidance for fish consumption.<sup>59,60</sup> Dietary “market basket” surveys are used by EPA’s Office of Pesticide Programs to evaluate aggregate exposure to pesticide residues in food to which consumers may be exposed. This is a different approach that involves analysis of exposure to a single chemical by multiple pathways and routes of exposure. Market basket surveys conducted by EPA’s Office of Pesticide Programs are statistically designed and executed on a single-serving basis at the point of sale to the consumer.<sup>61</sup>

Brief descriptions of fish consumption survey methodologies, including the strengths and weaknesses of each approach, are provided below.

### Creel surveys

Creel surveys estimate fish consumption through on-site interviews of anglers. A fish consumption rate is determined by using the number of fish caught at a given location divided by the number of people who will consume the catch.<sup>62</sup>

A number of creel surveys have been conducted in Washington. Examples are:

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<sup>55</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

<sup>56</sup> IBID

<sup>57</sup> Moya et al., 2008. Moya, Jacqueline; Itkin, Cheryl; Selevan, Sherry G.; Rogers, John W.; Clinckner, Robert P. Estimates of Fish Consumption Rates For Consumers of Bought and Self-Caught Fish In Connecticut, Florida, Minnesota, and North Dakota. *Science of the Total Environment*. 403 (2008) 89-98.

<sup>58</sup> Washington State Department of Ecology. DRAFT: Analysis and Selection of Fish Consumption Rates for Washington State Risk Assessments and Risk-Based Standards. By Leslie Kiell and Lon Kissinger. March 1999.

<sup>59</sup> U.S. EPA. Guidance for Conducting Fish and Wildlife Consumption Surveys. EPA-823-B-98-007. November 1998.

<sup>60</sup> U.S. EPA. Consumption Surveys for Fish And Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001.

<sup>61</sup> U.S. EPA. Choosing A Percentile Of Acute Dietary Exposure As A Threshold of Regulatory Concern. Office of Pesticide Programs. March 16, 2000. Web location: <http://www.epa.gov/oppead1/trac/science/trac2b054.pdf>

<sup>62</sup> Moya, Jacqueline 'Overview of Fish Consumption Rates in the United States', *Human and Ecological Risk Assessment: An International Journal*, 10: 6, 1195-1211 (2004).

- Landolt M.L., A. Nevissi, G. van Belle, K. Van Ness, and C. Rockwell, *Potential Toxicant Exposure among Consumers of Recreationally Caught Fish from Urban Embayment's of Puget Sound*. National Oceanic and Atmospheric Administration Technical Memorandum. Rockville, Maryland. 1985 (Final Report).
- Piece, D., Novielow D.T., and S.H. Rogers. *Commencement Bay Seafood Consumption Study. Preliminary Report*. Tacoma-Pierce County Health Department. Tacoma, Washington. 1981.
- McCallum, M. *Recreational and Subsistence Catch and Consumption of Seafood from Three Urban Industrial Bays of Puget Sound: Port Gardner, Elliott Bay, and Sinclair Inlet*. Washington Division of Health, Epidemiology Section. January 1985.

As with any type of survey, creel surveys have both strengths and weaknesses.<sup>63</sup> One advantage of creel surveys is that the interviews are usually conducted at fishing locations, which provides water-body specific information about species caught.

**Table 9. Strengths and Weaknesses of Creel Surveys**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>* Can assess site-specific consumption rates</li> <li>* Can target specific at - risk populations who fish at contaminated sites</li> <li>* The interviewer can observe the participant's fishing behaviors and catch as well as the condition of the interview site</li> <li>* Recall bias is minimized using visual aids and by having the interviewer refer to the fish caught around the time of the interview as a reference</li> <li>* Results can be verified by looking at the daily catch of the participant</li> <li>* Response rate is high</li> <li>* More information can be gained by using visual aids and probing</li> <li>* Creel surveys are routinely done for fishery management purposes, adding fish consumption questions to the surveys can be done with little added cost</li> </ul>	<ul style="list-style-type: none"> <li>* Only a limited number of questions so that survey time is minimized</li> <li>* Language barriers may exist between participants and interviewers</li> <li>* Surveys require well trained staff that must be monitored for quality control</li> <li>* If interviews are occurring at fishing sites, answers about consumption are hypothetical because the fish have not yet been consumed</li> <li>* Participants who fish more frequently are more likely to be interviewed than those who fish less frequently<sup>64</sup></li> <li>* Cannot be generalized to the entire population</li> </ul>

## Personal interviews

Personal interviews can be used to estimate fish consumption rates by asking participants questions about their dietary patterns, particularly about how much fish they consume over a given amount of time. A useful type of personal interview survey considers 24-hour dietary recall. In this type of interview, participants are asked by a trained interviewer to report what they ate during the previous 24 hours. Although the 24-hour dietary recall format avoids recall

<sup>63</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

<sup>64</sup> Moya, Jacqueline. 'Estimates of Fish Consumption Rates for Consumers of Bought and Self-caught Fish in Connecticut, Florida, Minnesota, and North Dakota'. *Science of the Total Environment*. 403 (2008) 89-98.

bias, the short time period of recall is unable to show consumption variation over the course of a year.<sup>65</sup>

Examples of personal interview surveys include the Native American fish consumption surveys conducted for tribes residing along the Columbia River basin and throughout the Puget Sound. (Discussed in Chapter 4.)

**Table 10. Strengths and Weaknesses of Personal Interviews**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>* Can assess site-specific consumption rates.</li> <li>* Can identify and get information from vulnerable subpopulations (those populations at a disproportionate risk) by collecting data from participants who are close to contaminated sites and by asking community agencies who should be interviewed.</li> <li>* Responses can be validated and supported with information gathered by the interviewer.</li> <li>* Literacy and language barriers are minimized by face-to-face interaction.</li> <li>* Visual aids can be used to estimate meal size or fish species, reducing recall bias.</li> <li>* High response rate.</li> <li>* Interviewer can clarify questions for respondents.</li> </ul>	<ul style="list-style-type: none"> <li>* Time restrictions may limit the number and types of questions</li> <li>* Requires coordinated and supervised interviewers.</li> <li>* If interviews are occurring at fishing sites, answers about consumption are hypothetical because the fish have not yet been consumed.</li> </ul>

## Diary surveys

Diary surveys use questionnaires, in the form of logbooks, diaries, or catch cards, to record fish consumption over time. Information is filled out by the participant ideally at the end of a fishing day or at the time of consumption, to minimize possible recall bias.

The Connecticut Department of Environmental Protection used diary surveys to find out about fish meals and portion sizes eaten by Connecticut families. The families received the surveys in the mail.<sup>66 67</sup>

<sup>65</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

<sup>66</sup> Moya, Jacqueline. 'Estimates of Fish Consumption Rates for Consumers of Bought and Self-caught Fish in Connecticut, Florida, Minnesota, and North Dakota'. *Science of the Total Environment*. 403 (2008) 89-98.

<sup>67</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

**Table 11. Strengths and Weaknesses of the Diary Method**

Strengths	Weaknesses
<ul style="list-style-type: none"><li>* Can assess site-specific consumption rates.</li><li>* Information collected over long periods of time,</li><li>* Less expensive than personal interviews.</li><li>* Large numbers of participants possible.</li><li>* Recall bias is reduced.</li><li>* Visual aids can be used to improve accuracy of answers.</li></ul>	<ul style="list-style-type: none"><li>* Respondents must be taught how to complete the survey by a trained interviewer</li><li>* Participants must be literate.</li><li>* Participants must be monitored during the study to maintain consistency.</li><li>* Keeping a dietary record may change a participant's dietary practices.</li><li>* Participants may not maintain daily record keeping.</li><li>* Language barriers may affect how participants are recruited and how their diary responses are interpreted.</li><li>* Questionnaire design is more complicated than other types of surveys.</li></ul>

## Telephone surveys

Telephone interview surveys estimate recent fish consumption or information about recent fishing trips. Answers are recorded on preprinted questionnaires.<sup>68</sup>

**Table 12. Strengths and Weaknesses of Telephone Surveys**

Strengths	Weaknesses
<ul style="list-style-type: none"><li>* Can assess region-specific consumption rates</li><li>* Can target and identify specific subpopulations of concern</li><li>* Less expensive and time-consuming than personal interviews.</li><li>* High rate of success for completion of interviews.</li><li>* Sensitive information may be obtained more easily.</li><li>* Provides immediate response to questions.</li></ul>	<ul style="list-style-type: none"><li>* Interviewers cannot reach people who do not have phones.</li><li>* Interviews are limited in scope and length.</li><li>* Difficult to verify information.</li></ul>

## Recall mail surveys

Recall mail surveys are self-administered questionnaires used to estimate fish consumption. Most commonly they are used to obtain information from recreational anglers.<sup>69</sup>

<sup>68</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

<sup>69</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

**Table 13. Strengths and Weaknesses of Recall Mail Surveys**

Strengths	Weaknesses
<ul style="list-style-type: none"><li>* Can assess region-specific consumption rates.</li><li>* Can target and identify specific subpopulations of concern.</li><li>* Least expensive since no interviewers are required.</li><li>* Large numbers of respondents may be contacted over a large area.</li><li>* Most likely to provide honest answers.</li><li>* Complex technical data may be obtained if respondent takes the time to consider the questions and/or consult other sources.</li><li>* Survey can cover broad areas of inquiry.</li></ul>	<ul style="list-style-type: none"><li>* Cannot reach people without mailing addresses.</li><li>* Questions must be carefully designed to compensate for lack of personal interaction.</li><li>* Questions should be limited in scope and complexity.</li><li>* Requires substantial followup efforts or incentives to achieve reasonable response rate</li><li>* Higher number of inaccurate and incomplete responses.</li><li>* May miss respondents who are illiterate, or have difficulty in understanding questions, or who cannot read the language.</li></ul>

## Survey selection criteria

Both dietary recall interviews and creel surveys have been used in Washington in various contexts to estimate fish consumption rates. (See Chapter 4, Table 17.)



**Table 14. Comparison of Five Consumption Survey Methodologies Using EPA's Selection Criteria<sup>70</sup>**

Survey type Selection Criteria	Telephone	Mail	Diary	Interview	Creel
<b>Time Frame</b>					
Immediate data from respondent	Yes	No	No	Yes	Yes
<b>Resources</b>					
Interviewer burden	Moderate	Low	Low	High	High
Respondent burden	Low	Moderate	High	Low	Low
Relative cost	Moderate	Low/moderate	Low	High	High
<b>Target Populations/Subpopulations</b>					
Survey sample known prior to conducting survey	Yes/no <sup>a</sup>	Yes	Yes	Yes/no <sup>b</sup>	Yes/no <sup>c</sup>
Can be used with low literacy-rate populations	Yes	No	No	Yes	Yes
<b>Accuracy</b>					
Reliability: Potential for response reliability	Moderate/high	Low/moderate	Low/moderate	Moderate/high	Moderate/high
Validity: Validity of consumption estimates	Low	Low/high <sup>e</sup>	Moderate	Low/moderate <sup>f</sup>	Moderate <sup>f</sup>
Validity: Validity of species identification	Low	Moderate	Moderate	Moderate/high <sup>g</sup>	High
Bias: Potential to minimize recall bias	Moderate	Low/high <sup>e</sup>	Moderate	Moderate/high <sup>g</sup>	Not applicable
Bias: Potential to minimize prestige bias	Moderate	Low	Low	Moderate	Moderate
Measurement error: opportunity for respondent to ask for clarification	Moderate/high	Low	Low	High	High
Measurement error: potential for respondent participation	Moderate	Moderate	Low	High	High
<b>Harvest Characteristics</b>					
Many access points	Yes	Yes	Yes	Yes/no <sup>b</sup>	Yes/no <sup>h</sup>
High fishing or hunting pressure	Yes/no <sup>i</sup>	Yes	No	Yes	Yes/no <sup>i</sup>
Large geographic area	Yes	Yes	Yes	No	No

Explanatory Notes for the table above

a Yes if phone numbers are obtained after sample population has been preselected; no if random digit dialing.

b No for interviews conducted at fish/hunting access points; yes for off-site interviews.

c Depends on ability to estimate total site usage using random sampling of all access points.

d Given sufficient resources, all five survey approaches can generate accurate data.

e Dependent on the recall method employed.

f On-site interviews result in valid catch estimates, but consumption estimates are hypothetical because they measure only the intent to consume. Off-site interviews result in catch and consumption estimates with potentially low validity depending on the period of recall.

g Moderate for off-site interviews; high for on-site interviews.

h Yes for roving creel survey; no for access point survey.

i Yes for random telephone numbers; no for known telephone numbers.

j Yes for access point survey; no for roving creel survey.

Certain criteria are useful for comparing survey methodologies and key factors influence the selection of a particular survey type.<sup>71</sup> These selection criteria assist in discriminating between

<sup>70</sup> U.S. Environmental Protection Agency. Guidance for Conducting Fish and Wildlife Consumption Surveys. EPA-823-B-98-007. November 1998. Table 3, page 3-3

different survey approaches. In addition, how different survey methodologies compare based on these criteria highlights the various strengths and weaknesses.

Consistent with this approach, Ecology established key considerations for selection criteria: time frame, resources, target populations, subpopulations, accuracy, and harvest characteristics. Although many of these considerations are discussed separately, the table provides a useful tool for comparing different survey methodologies.

## Evaluating survey vehicles

Large differences in survey objectives combined with the high variability in fish consumption patterns make it difficult to make generalizations about surveys. To compare and evaluate both the survey vehicle and the data obtained, a number of factors should be considered. Also, to establish the appropriateness for using a particular survey, each factor needs to be evaluated and documented.<sup>72</sup>

### General survey design

Survey design is fundamental, and identifying the target population is important when both choosing a survey method and effectively executing the survey. The design establishes the type of information collected and the level of detail provided.<sup>73</sup> Survey accuracy improves when the following seven factors are considered during the design phase. Ecology considered these as essential in a well-designed survey:

- Timing of interviews
- Training interviewers
- Consideration of all fish species
- Identification of the source
- Random selection of participants, sample size, and statistical analysis
- Appropriate quality assurance and quality control
- Accuracy

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<sup>71</sup> U.S. Environmental Protection Agency. Guidance for Conducting Fish and Wildlife Consumption Surveys. EPA-823-B-98-007. November 1998.

<sup>72</sup> Moya 2004 and EPA 1992, 1998 identify important elements of survey design.

<sup>73</sup> Moya, Jacqueline 'Overview of Fish Consumption Rates in the United States', *Human and Ecological Risk Assessment: An International Journal*, 10: 6, 1195-1211 (2004).

**Table 15. Survey Design Evaluation Criteria**

- \* Timing of interviews: For a survey to adequately capture fish consumption, an appropriate time frame must have been chosen that minimizes the effect of recall bias yet captures the dietary variations.<sup>74</sup> (Additional discussion on survey recall error and bias are provided in the Glossary.)
- \* Training of interviewers: Interviewers should be trained for the study protocol to avoid potential interviewer bias. Interviewers must stick to the questionnaire wording and format and be culturally sensitive when interacting with the study participants. If possible, interviews should be conducted by members of the target population to avoid cultural differences, language barriers, and participation refusals.<sup>75</sup>
- \* Consideration of all fish species: The types of fish consumed can be highly variable depending on seasonal and geographic availability, market prices, and cultural preferences. Surveys should identify and record each type of fish consumed.<sup>76</sup>
- \* Identification of the source: If known, identify either the water body where the fish was caught or the purchase location (for example, grocery store or fish market). In an effort to improve exposure assessment, include both locally caught fish and store bought fish in fish consumption rate estimates. This distinction allows the risk assessor to better account for regional and seasonal variations in fish consumption estimates.<sup>77</sup>
- \* Random selection of participants, sample size, and statistical analysis: During the planning phase, statistical analysis helps identify the ideal sample size and how to randomly select participants. This analysis helps minimize bias and sampling error and ensures statistical rigor. After the data has been collected, sound descriptive statistical analysis should ensure that the data is presented accurately. The range of data should be presented with confidence intervals and appropriate distribution values.
- \* Appropriate quality assurance and quality control: The study design should include appropriate quality assurance and quality controls into the planning and execution of the survey. For example, types of quality control measures would include checking of questionnaires for completeness and proper entry of recorded responses, verifying correct data entry, and checking the manual coding operations and comparisons of results and error rates. This reduces bias and random error, improving accuracy.<sup>78</sup>
- \* Accuracy: The study design can affect the overall accuracy of the study. Accuracy can be split into five components. Reliability (the variability or repeatability of the response), validity (the ability of the respondent to provide the correct answer), measurement errors (which are associated with the interviewer, the respondent, the questionnaire, and the mode of data collection), bias (the consistent overestimation or underestimation due to survey design and sample selection), and random errors.<sup>79</sup>

## Survey questionnaire

The following information should be collected from study respondents. This list provides the necessary understanding of the respondent and what they eat. (See H. Strauss 2004 for details regarding complexities and variability.<sup>80</sup>)

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<sup>74</sup>Washington State Department of Ecology. DRAFT: Analysis and Selection of Fish Consumption Rates for Washington State Risk Assessments and Risk-Based Standards. By Leslie Kiell and Lon Kissinger. March 1999.

<sup>75</sup>IBID.

<sup>76</sup>IBID.

<sup>77</sup>Ebert ES, Price PS, Keenana RE (1994). Selection of Fish Consumption Estimates for Use in the Regulatory Process. *Journal of Exposure Analysis and Environmental Epidemiology* 4: 373-393.

<sup>78</sup>U.S. Environmental Protection Agency. Guidance for Conduction Fish and Wildlife Consumption Surveys. November 1998. EPA-823-B-98-007.

<sup>79</sup>IBID.

<sup>80</sup>Strauss Harlee. 'Sportsfish Consumption Surveys: A Risk Assessment Practitioner's Wish List', *Human and Ecological Risk Assessment: An International Journal*. 10: 6, 1213-1225. (2004).

- Frequency and quantity (how much fish is consumed per day, week, or month)
- Parts of the fish consumed
- Species consumed
- Cooking methods
- Respondent's body weight
- Exposure duration
- Approximate age (child or adult)

Clear and correct answers require clarity in the survey vehicle. Questions should be unambiguous and well understood.

### **Population surveyed**

The sample population must be representative of the target population. This is particularly important because fish consumption rates may be affected by the sociodemographic characteristics of a population.<sup>81</sup> Furthermore, the type of survey used may influence or determine a number of things, including what population will respond to the survey, the response rates, and the level of detail obtained.<sup>82</sup>

### **Description of water body**

The survey must identify and understand the characteristics of all relevant water bodies, including location, size, species habiting the water, and fish advisory status. These characteristics influence the quantity of fish available. In addition, this information is critical to produce results that can be used to compare with or extrapolate to other populations.<sup>83</sup>

### **Survey results**

Ecology considered it important to evaluate how the survey results are presented and what they are meant to represent. This included identifying and considering goals of the survey.

Estimating the size of a meal is subject to error, especially with a survey vehicle lacking visual aids.

Sound descriptive statistical analysis is required to ensure that the data is presented accurately. The range of data should be presented with confidence intervals and appropriate distribution values.<sup>84</sup>

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<sup>81</sup> Moya, Jacqueline 'Overview of Fish Consumption Rates in the United States', *Human and Ecological Risk Assessment: An International Journal*, 10: 6, 1195-1211 (2004).

<sup>82</sup> IBID.

<sup>83</sup> IBID.

<sup>84</sup> Moya, Jacqueline 'Overview of Fish Consumption Rates in the United States', *Human and Ecological Risk Assessment: An International Journal*, 10: 6, 1195-1211 (2004).

## Factors to consider

Ecology identified the following factors as appropriate and necessary when evaluating survey results:

- Cultural factors. Does the population group (for example, Native Americans or Asian and Pacific Islanders) have cultural characteristics that should be considered when designing or evaluating fish consumption? Native American lifeways may influence fish consumption habits and patterns; salmon is of particular significance in the diet of Northwest Pacific Native American tribal peoples. Also, is the survey designed to identify subsistence fishing practices?
- Fish diet fraction. Have sources of fish tissue contamination been considered in the design and/or evaluation of the survey? Are the fish consumed harvested from local waters? Does the survey distinguish between store-bought fish and fish harvested from local waters?
- Types of seafood (fish and shellfish) consumed from marine, freshwater, and estuarine habitats. Has the fish consumption survey considered both the range of types of fish/shellfish consumed and where they are harvested?
- Cooking methods. Using cooked weights or uncooked weights to measure fish consumed must be standardized. Cooking fish can reduce the weight of a fillet by 20 percent.<sup>85</sup> Have the methods of food preparation and cooking methods been considered in the fish consumption survey design and/or evaluating the survey?
- Cultural differences. Are there cultural practices or customs that may confer a disproportionate risk for high fish consumers?
- Treaty-reserved rights and customs. Are there historical and traditional fishing areas and practices that should be identified?
- Environmental justice. How have historically underrepresented populations and disproportionately impacted communities been considered in the design and/or evaluation of fish consumption? Have questions related to civil rights been considered?

## Measures of technical defensibility

It is important to establish the scientific defensibility of survey data used in a regulatory context. For purposes of this report, Ecology developed several “measures of technical defensibility” to help guide the evaluation of individual surveys (Table 16).

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<sup>85</sup> U.S. Environmental Protection Agency. Guidance for Conducting Fish and Wildlife Consumption Surveys. November 1998. EPA-823-B-98-007.

**Table 16. Measures of Technical Defensibility**

1. Survey Method Development
* Was the survey design based on sound scientific survey methods recognized either in guidance or other technical publications?
* Was the survey vehicle – tribe staff and tribal government, review and collaboration with state and federal agencies
* Was the survey beta tested before it was conducted?
2. Execution of Survey Vehicle
* Was the execution of the survey based on sound survey methods recognized either in guidance or other technical publications?
* Were the personnel conducting interviews provided adequate training?
* Were fish /shellfish models used to help participants estimate approximate amounts and types of fish consumed?
3. Publication of Results
* Was the publication of survey results based on sound survey methods recognized either in guidance or other technical publications?
* Was the study methodology clearly defined and reported?
* Was the study methodology consistent with sound survey practices?
* Were the survey results tabulated and reported clearly?
* Were the study conclusions clearly reported and supported by study findings?
* Were variability and uncertainty recognized?
* Were uncertainties identified and reported?
* Did the survey design take into account and/or discuss factors that might contribute to bias in the study results?
4. Applicability and Utility for Regulatory Decision-Making
* Is the sample population representative of the population of concern, and does the survey provide sufficient information about the population?
* Is the information current?
* Are exposure estimates sufficiently identified and is data sufficient for descriptive statistics to define statistical distributions?
5. Overall Technical Suitability to Support Regulatory Decision-Making
* Are the results of the survey suitable and can they be used in a regulatory context?
* What is the range of technical defensibility based on the above criterion?
* Can the results be considered appropriate for establishing risk-based standards?

These measures are based on:

- EPA *Exposure Factors Handbook*, (2009 Update).<sup>86</sup>
- EPA Guidance for Conducting Fish and Wildlife Consumption Surveys.<sup>87,88</sup>
- Consultations with the University of Washington, Environmental and Occupational Health Sciences.<sup>89</sup>

<sup>86</sup> U.S. EPA. Exposure Factors Handbook: 2009 Update. July 2009. EPA/600/R-09/052A.

<sup>87</sup> U.S. EPA. Guidance for Conducting Fish and Wildlife Consumption Surveys. November 1998. EPA-823-B-98-007.

<sup>88</sup> U.S. EPA. Consumption Surveys for Fish and Shellfish, A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

The measures include elements of survey method development, the execution of the survey, publication of the results of the survey, survey standards of relevance, applicability and utility, as well as consideration of suitability to support risk-based decisions. These measures help respond to questions regarding survey development and execution, publication of the survey results, and relevance and suitability to help support regulatory decision making. As described in Chapter 4, Ecology applied these measures to evaluate available fish consumption surveys to determine appropriateness for use in establishing a technically defensible default fish consumption rate for regulatory use.

## Standards applied to establishing defensibility

There are a number of ways to establish the defensibility of data. Scientific journals use peer review to establish scientific defensibility of reported results. A recent *Science Magazine* editorial noted the importance of making data available for scrutiny so that other researchers can verify results and test conclusions.<sup>90</sup>

Native American fish consumption surveys conducted in the Pacific Northwest are published under the authority of the different tribal governments. Pacific Northwest Native American fish consumption surveys are designed and executed as government-to-government collaboration with state and federal governments. Data is retained by tribal governments or Pacific Northwest Indian commissions.

For example, the fish consumption survey of the four tribes that reside throughout the Columbia River basin was initiated through a cooperative agreement between EPA and the Columbia River Inter-Tribal Fish Commission (CRITFC). The development, design, and execution of the CRITFC fish consumption survey vehicle were conducted through the respective tribal governments that compose CRITFC. The fish consumption data collected and evaluated by tribal members and technical staff is retained by CRITFC. Other Pacific Northwest Indian tribes follow a similar pattern where the data is retained by tribal governments or Pacific Northwest Indian commissions.

Pacific Northwest tribal governments or commissions typically handle survey data as confidential and do not allow independent evaluations. Data evaluation typically occurs through government-to-government agreements or tribal technical personnel. Consequently, most studies are not evaluated through a separate scientific peer review process (such as peer review prior to publication in a scientific journal). This has led to questions regarding the credibility of Native American surveys.

Most fish dietary surveys that detail the fish dietary habits and patterns for ethnic groups (Asian and Pacific Islanders; Native American populations) are funded through state or federal cooperative agreements or grants. The development of the survey questionnaire is done in close

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<sup>89</sup>Ecology acknowledges input from the University of Washington, Seattle, Environmental and Occupational Health Sciences and Departments of Medicine and Internal Medicine.

<sup>90</sup> Science Magazine, 11 February 2011, page 649

collaboration with an organization that represents the ethnic group or technical personnel associated with the tribal governments or tribal natural resource offices. The execution of the survey is performed by trained tribal personnel or people representative of the ethnic population being surveyed. Data ownership remains under the exclusive ownership of the tribal government or the ethnic group that worked on the survey development and execution. Survey design and methodology is reviewed by the funding organization – federal and/or state organization – and technical tribal personnel or other personnel belonging to the ethnic group associated with the survey design and execution.

Ecology evaluated the Native American fish consumption surveys, as well as other available surveys conducted in the Pacific Northwest, based on the measures of technical defensibility discussed above. That evaluation is described in the following chapter.



# Chapter 4: Fish Consumption Survey Data Applicable to Washington Fish Consumers

## Introduction

Over the last several years, Ecology has evaluated available fish consumption surveys to support site-specific regulatory decisions. This chapter reviews and summarizes this and other data regarding fish consumption in Washington or data relevant to Washington. The goal of this inquiry is to identify and evaluate the currently available data on fish consumption rates and apply measures of technical defensibility to identify which are appropriate for use in establishing a default fish consumption rate (or rates) for the state.

This chapter:

- Identifies earlier evaluations and summarize available surveys and fish consumption rates derived from each survey.
- Provides an initial determination on which studies Ecology identifies as providing a sound basis for establishing a statewide default fish consumption rate (or rates) appropriate for use in regulatory decisions.

This chapter identifies the surveys considered by Ecology. Metrics establishing technical defensibility follow a discussion of each qualifying survey.

## Surveys and information considered by Ecology

Ecology considered a range of information that describes fish consumption rates and patterns for fish consumers in Washington. In general, Ecology examined:

- Dietary surveys of Washington Native American populations
- Dietary surveys of Washington Asian and Pacific Islander populations
- National information on per-capita U. S. fish consumption
- Various evaluations or assessments used for regulatory decisions (for example, the *Lower Duwamish Water Baseline Human Health Risk Assessment*)
- Technical publications, assessments, and/or evaluations on fish consumption specific to the Pacific Northwest
- Washington water-body specific evaluations, assessments, or health advisories issued by the Washington Department of Health

Table A-1 in Appendix A summarizes fish consumption survey information that Ecology identified as relevant and suitable for establishing a default fish consumption rate for Washington. In developing this list, Ecology reviewed available information on consumption

rates, habits, customs, and patterns for the fish-consuming populations of Washington. The review resulted in identifying the scientific and technical data available for specific evaluation; that is, which data could appropriately be used to establish default fish consumption rates.

The rest of this chapter describes the qualifying surveys and information and presents results of the evaluation.

## Pacific Northwest Native American fish consumption data

As of the writing of this report, results of three tribal-specific fish/shellfish dietary surveys of tribes along the Columbia River basin and in the Puget Sound area of Washington were available for review.

In addition, several technical publications provide tribal fish consumption related information. These publications have been used to define a tribal reasonable maximum exposure for various regulatory decisions.<sup>91,92,93</sup>

Although these technical publications provide useful information for specific regulatory decisions, the published tribal fish consumption surveys provide the best information on fish consumption. Furthermore, these surveys employed a well-defined standardized dietary survey methodology, data analysis, and reporting of results.

This section describes the three surveys, along with an evaluation of technical defensibility.

### **Columbia River Inter-Tribal Fish Commission survey: the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin**

The Columbia River Inter-Tribal Fish Commission surveyed fish consumption among four Native American tribes that reside along the Columbia River basin.<sup>94</sup> The survey of adult tribal members who lived on or near the Yakama, Warm Springs, Umatilla, or Nez Perce Reservations was conducted during the fall and winter of 1991–1992.

The survey identified individual tribal members' consumption rates, habits, and food preparation methods of anadromous and resident fish species caught from the Columbia River basin. A random sampling was taken based on respondents selected from patient registration files of the Indian Health Service. The survey questionnaire included a 24-hour diet recall and questions

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<sup>91</sup> Barbara L. Harper, Brian Flett, Stuart Harris, Corn Abeyta, and Fred Kirschner. The Spokane Tribe's Multipathway Subsistence Exposure Scenario and Screening Level RME. Risk Analysis, Vol 22, No. 3, 2002, pages 513-526. [Table 11, page 521 notes 885 – 1000 g/day for those with a high fish diet (fish consumers) and 175 g/day for shellfish consumption for fish consumers and nonconsumers of fish].

<sup>92</sup> Stuart G. Harris and Barbara L. Harper. A Native American Exposure Scenario. Risk Analysis, Vol. 17, No. 6, 1997, pages 789-795.

<sup>93</sup> Stuart Harris and Barbara L. Harper. Lifestyles, Diets, and Native American Exposure Factors Related to Possible Lead Exposures and Toxicity. Environmental Research Section A 86, 2001, pages 140-148.

<sup>94</sup> Columbia River Inter-Tribal Fish Commission. (CRITFC, 1994) A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. (1994) Technical Report 94-3, Portland, Oregon.

regarding seasonal and annual fish consumption. Food models were used to help respondents estimate the amounts of fish consumed.

Information obtained included age-specific fish consumption rates, the fish species and parts of the fish consumed, and the methods used to prepare the fish for consumption.

Personal interviews conducted on the four tribal reservations achieved an overall response rate of 69 percent from a sample size of 513 tribal members 18 years of age or older. Tribal adult respondents provided information for 204 children 5 years of age or younger. Since tribal population sizes were unequal, weighting factors were applied to the pooled data in proportion to tribal population size, so that survey results would reflect the overall population of the four tribes for adults only. An unweighted analysis was performed for children, since the sample size for children was small. Consumption rates were derived by averaging consumption for both consumers and nonconsumers of fish, to be more representative of the adult tribal population as a whole.

Salmon and steelhead were consumed by the largest number of adult respondents, followed by trout, lamprey, and smelt. Most fish were consumed during April through July. The mean fish consumption rate was 108 grams/day. There was a large seasonal variation in fish consumption. The reported mean rate of consumption during the high months (April–July) was three times the mean rate of consumption in low months (November–February).

The mean fish consumption rate for all surveyed tribal adults (consumers and nonconsumers) throughout the year was 58.7 grams/day. Seven percent of survey respondents did not consume fish. Excluding nonconsumers of fish, the mean fish consumption rate for surveyed tribal adult fish consumers was 63.2 grams/day. The average consumption rate for children (5 years old and younger) was 24.8 g/day. About 83 percent of the 204 children consumed fish. The 99<sup>th</sup> percentile fish consumption rates of adults and children (5 and younger) who consume fish were 389 g/day and 162 g/day, respectively.

	Number of Adults Surveyed	Descriptive Statistics (g/day)					
		Mean	Median	Percentiles			
				75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	99 <sup>th</sup>
Columbia River Tribes	512	63	40	60	113	176	389

*Technical defensibility:* Ecology concludes that the 1994 survey is relevant to Washington and satisfies measures of technical defensibility.

**Table 17. Evaluation of Technical Defensibility**

**An Evaluation of Technical Defensibility and Suitability of Washington Fish Consumption Rate Surveys by the Washington Department of Ecology for Use in Regulatory Decision Making**

**Survey Name: Columbia River Inter-Tribal Fish Commission (CRITFC) Consumption Survey**

**Survey Author: Columbia River Inter-Tribal Fish Commission (CRITFC), 1994**

Metric	Observations & Comments	Evaluation
1. Survey Method Development		
a. Type and description of survey vehicle	24-hour & seasonal dietary recall personal interview survey; respondents were randomly selected from Indian Health Service records; a large range of fish were considered in the survey (salmon, lamprey, smelt)	The survey method and vehicle were developed in a technically defensible manner.
b. Collaboration and review	CRITFC staff developed the survey in collaboration with Washington DOH, EPA HQ & Region 10 staff, IHS staff; it was reviewed by tribal governments of the CRITFC member tribes (Nez Perce Tribe, Confederated Tribes and Bands of the Yakama Indian Nation, Confederated Tribes of the Warm Springs and Umatilla Indian Reservations),	
c. Beta testing	The survey was tested by tribal staff in consultation with EPA.	
2. Survey execution		
a. Establish & document execution standards	Execution of survey vehicle by native population documented; data gathered on adult respondents 18 years or older and children 5 years or younger	The survey vehicle was appropriately executed and documented; use of fish models was documented.
b. Document staff training	Native staff trained personnel in collaboration with and with technical oversight provided by state/federal agencies.	
c. Fish/shellfish Models used	Fish models were employed to aid in identifying the amount of fish and shellfish consumed.	
3. Publication of results		
a. Where were results published? Are they clear and complete?	Results were published in a CRITFC tribal government publication. The population surveyed, method used, conclusions, and tabulations were well defined, presented, and documented. The highest fish consumers were considered outliers and were dropped from the survey data and, therefore, were not statistically evaluated.	The data presented is sufficient to develop consumption distributions with percentiles.
b. Methodology reported	The methodology used is clearly described and documented	
c. Results tabulated & stated	Survey results are reported and summarized in a tabular format suitable for distributional descriptive statistics; the report documents an acceptable response rate (69%).	
d. Conclusions clearly reported	Conclusions are stated and correspond to data tabulated.	
e. Variability and uncertainty	Variability and uncertainty were qualitatively recognized and noted.	
f. How is the potential for bias addressed?	The possibility for bias in the survey methodology is recognized and discussed.	
4. Applicability and utility for regulatory decision making		
a. Representation of target population	The survey provides a reasonable estimate of fish consumption for CRITFC member Native populations within the Columbia River Basin (Nez Perce Tribe, Confederated Tribes and Bands of the Yakama Indian Nation, Confederated Tribes of the Warm Springs & Umatilla Indian Reservations)	This survey meets the standards of relevance, applicability, and utility and is appropriate for use in regulatory decision making
b. Currency of information	Surveys were conducted in the early to mid-1990s; more recently, the CRITFC estimates were used by Oregon DEQ for in developing water quality standards (2011).	
c. Sufficiency of data	The fish consumption estimates are sufficient to provide descriptive statistics for defined distributions and percentiles for risk-based decision making.	
5. Overall technical suitability for regulatory decision making		
a. Range of technical defensibility	Survey design, development of methodology, execution of survey, data interpretation, and conclusions for fish consumption provide a reasonable quantitative exposure estimate of fish consumption rates for target populations.	Ecology concludes survey is technically defensible.
b. Appropriateness for use in risk-based standards	The data is sufficient to provide distribution and percentile estimates of fish consumption as required for risk-based decision making.	
Reference: Columbia River Inter-Tribal Fish Commission. (CRITFC, 1994) A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin. (1994) Technical Report 94-3., Portland, Oregon.		

#### **Additional information reviewed**

- Harris and Harper (1997) report that a fish consumption rate of 540 g/day represents a reasonable subsistence fish consumption rate for CRITFC's member tribes who pursue a traditional lifestyle.<sup>95</sup> They base this on their review of several nonsubsistence Native American studies, two subsistence studies, and personal interviews of members of the Umatilla and Yakama Tribes.
- A further examination of Columbia River basin tribal populations used information and data collected from the 1994 Columbia River Inter-Tribal Fish Commission's fish consumption survey.<sup>96</sup> Because of concerns due to chemical contaminants in water and fish for tribal fish-consuming populations along the Columbia River basin, the tribal populations' characteristics were examined for children, women of child-bearing age, and tribal elders who may be susceptible to adverse health effects from exposure to contaminants due to high fish consumption. A multivariate analysis showed a positive association between fish consumption rates and factors including breastfeeding after the most recent births, percent of fish obtained noncommercially for women who recently gave birth, living off the reservation, and fish consumption for children and the elderly. About 50 percent of women, 80 percent of tribal elders, and at least 40 percent of children consume nonfillet fish parts. Although this reevaluation did not result in any changes or corrections in Columbia River basin tribal consumption rates, it provided additional information regarding susceptible tribal populations that consume fish.

#### **Tulalip and Squaxin Island Tribes of the Puget Sound Region (Toy et al. 1996)**

A survey of fish and shellfish consumption for the Tulalip and Squaxin Island tribes living in the Puget Sound region was conducted in 1994.<sup>97</sup>

The target populations included adult tribal members (18 years or older) randomly selected from tribal enrollments who lived on or within a 50-mile radius of the reservation and children aged five years or younger who lived in the enrolled member's household. The survey reported consumption rates of anadromous, pelagic, bottom fish, and shellfish in grams per kilogram body weight per day over a one-year period and the portion size of each meal. Adults who did not consume fish (less than 1 percent of those contacted) were not included in the survey. Fish/shellfish models were used to estimate portion sizes. Fish/shellfish preparation methods were identified, and sources of fish and shellfish consumed were reported by tribe and species groups.

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<sup>95</sup> Stuart G. Harris and Barbara L. Harper. A Native American Exposure Scenario. *Risk Analysis*, Vol. 17, No. 6, 1997, pages 789-795.

<sup>96</sup> Neil A. Sun Rhodes. Fish Consumption, Nutrition, and Potential Exposure to Contaminants Among Columbia River Basin Tribes. Master of Public Health Thesis. Department of Public Health and Preventive Medicine. Oregon Health & Science University. April 2006.

<sup>97</sup> Toy, K.A., Polissar, N.L., Liao, S., and Mittelstaedt, G.D., 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment, 7615 Totem Beach Road, Marysville, WA 98271.

A total of 190 successful interviews were completed during March through mid-May for adult tribal respondents. A tribal parent or guardian answered questions about the fish consumption for children from the same household. Only one child per household, selected randomly, was included in the survey, for a total of 69 children. Results from half of the adult respondents in the Tulalip tribe were dropped because one of the tribal interviewers did not follow the survey interview protocol. However, repeat interview were conducted by telephone as a followup with 10 percent of the survey respondents.

Anadromous fish and shellfish were most frequently consumed. The main source for the most frequently consumed fish (anadromous fish and shellfish) was local water bodies of the Puget Sound. Fish fillets with skin were consumed by up to 40 percent of the tribal respondents with mean percent consumption of fish parts (head, bones, eggs, organs, and skin) for up to 11 percent of tribal respondents consuming anadromous fish.

Weight adjusted consumption rates were calculated and reported by tribe, age, gender, income, and species group. The adult mean and median consumption rates for all forms of fish combined were 0.89 and 0.55 g/kg/day for the Tulalip tribes and 0.89 and 0.52 g/kg/day for the Squaxin Island tribe, respectively. Age-adjusted median fish consumption rates for the Tulalip Tribes were 53 g/day for males and 34 grams/day for females. Age adjusted median fish consumption rates for the Squaxin Island tribe were 66 g/day for males and 25 g/day for females. The mean and median consumption rate for children, five years and younger for both tribes combined, were 0.53 and 0.17 g/kg-day, respectively.

Tribe	Number of Adults Surveyed	Descriptive Statistics (g/day)					
		Mean	Median	Percentiles			
				75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	99 <sup>th</sup>
Tulalip	73	72	45	85	186	244	312
Squaxin Island	117	73	43	-	193	247	-

*Technical defensibility:* The survey of Tulalip and Squaxin Island Tribes of the Puget Sound Region (Toy et al., 1996) is relevant to Washington and is technically defensible.

**Table 18. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region**  
**Survey Author: Toy et al., 1996**

Metric	Observations & Comments	Evaluation
1. Survey method development		
c. Type and description of survey vehicle	Personal interview survey; 24-hour and seasonal dietary recall; fish/shellfish identification, portion, frequency, preparation, and harvest locations.	The survey method and vehicle were developed in a technically defensible manner.
d. Collaboration and review	Survey was developed in collaboration with Washington DOH, Washington Dept of Ecology, EPA Region 10, Tulalip Tribal Dept of Environment, Suquamish Tribal Fisheries Dept, Board of Directors for Tulalip & Squaxin Island Tribes, Columbia River Inter-Tribal Fish Commission, Fred Hutchinson Cancer Research Center in Seattle.	
e. Beta testing	Pilot survey and repeat interviews conducted	
2. Survey execution		
a. Establish & document execution standards	Execution of survey questionnaire documented with identifiable QA/QC procedures.	The survey vehicle was appropriately executed and documented; use of fish models was documented.
b. Document staff training	Two members from each tribe trained to conduct interviews.	
c. Fish/shellfish models used	Fish and shellfish models used for multiple species.	
3. Publication of results		
a. Where were results published? Are they clear and complete?	Fish/shellfish identification, portion, frequency, preparation, and harvest locations documented and reported.	The data presented in the Joint Tulalip and Squaxin Island tribal publication is sufficient to develop consumption distributions with percentiles.
b. Methodology reported	All phases of method development documented and reported.	
c. Results tabulated & stated	Tabulated species-specific consumption with descriptive statistics.	
d. Conclusions clearly reported	Conclusions reported with followup interviews for reliability and representation	
e. Variability and uncertainty	Noted and documented with note of "outliers" with reported rates for Squaxin & Tulalip tribes.	
f. How is the potential for bias addressed?	The possibility for bias in the survey methodology is recognized and discussed. Survey results from one interview did not follow protocol and were eliminated.	
4. Applicability and utility for regulatory decision making		
a. Representation of target population	Included range of different rates for enrolled Tulalip & Squaxin tribal members	This survey meets the standards of relevance, applicability, and utility and is appropriate for use in regulatory decision making.
b. Currency of information	Survey conducted in 1996; more recently the consumption estimates were used by Oregon DEQ in developing water quality standards (2011).	
c. Sufficiency of data	The data is sufficient to provide distribution and percentile estimates of fish consumption for Tulalip & Squaxin tribal populations	
5. Overall technical suitability for regulatory decision making		
a. Range of technical defensibility	Technically defensible dietary survey of the Suquamish Indian Tribe.	Ecology concludes the survey is technically defensible.
b. Appropriateness for use in risk-based standards	The data is sufficient to provide distribution and percentile estimates of fish consumption as required for risk-based decision making.	
Reference: Toy, K.A., Polissar, N.L., Liao, S., and Mittelstaedt, G.D., 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment, 7615 Totem Beach Road, Marysville, Washington 98271.		

## Suquamish Indian Tribe

The Suquamish Tribal Council conducted a fish consumption survey of Squamish tribal members living on and near the Port Madison Indian reservation in the Puget Sound area.<sup>98</sup> The survey was conducted to determine the fish/shellfish consumption rates, habits and patterns of the Suquamish tribe. Also, the study was conducted to identify fish consumption related cultural practices and tribal characteristics that might affect fish consumption rates, patterns and habits.

Consumption data was based on a random sample of adults (16 years and older) selected from the tribal enrollment roster. Consumption data for children was collected through adult respondents with children younger than 6 years old living in the household at the time of the survey. Consumption data was collected for 31 children under 6. The survey has a 64.8 percent participation rate based on 92 respondents out of a total of 142 potentially eligible tribal adults. The survey questionnaire was administered by trained tribal members using personal interviews and included:

- 24-hour dietary recall (fish meals eaten per day, per week, per month, or per year over a 1-year period and the portion size of each meal)
- Identification, portions, frequency of consumption, methods of preparation, harvest locations
- Shellfish consumption, methods of preparation, harvest location
- Changes in consumption over time, cultural information, physical information, and socioeconomic information.

Fish/shellfish models were used to assist tribal respondents regarding amounts and types consumed. Booklets were used to assist in identifying harvest locations of seafood consumed. Fish/shellfish were grouped into categories based on similarities in life history and practices of tribal members who fish for subsistence, ceremonial, and commercial purposes. The majority of fish/shellfish consumed by the Suquamish Tribe was harvested from the Puget Sound, with Pacific salmon and shellfish consumed more than other fish.

All 92 tribal respondents reported consuming some type of fish; hence, no nonconsumers of fish were surveyed. Survey results were recorded as grams/kg/day along with the respondent's body weight. Adult respondents reported a mean consumption rate of all finfish and shellfish consumption rate of 2.71 g/kg/day. For children under 6 years old, the mean consumption all finfish and shellfish was 1.48 g/kg/day. Below are weight-adjusted survey results for Suquamish adult fish consumers.

	Number of Adults Surveyed	Descriptive Statistics (g/day)					
		Mean	Median	Percentiles			
				75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	99 <sup>th</sup>
Suquamish Tribe	284	214	132	-	489	-	-

*Technical defensibility:* The 2000 survey of Suquamish Indian Tribe of the Port Madison Indian Reservations of Puget Sound is relevant to Washington and satisfies measures of technical defensibility.

<sup>98</sup> The Suquamish Tribe. 2000. Fish Consumption Survey of the Suquamish Indian Tribe of The Port Madison Indian Reservation, Puget Sound Region. August 2000.



**Table 19. Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region**  
**Survey Author: The Suquamish Tribe, 2000**

Metric	Observations & Comments	Evaluation
1. Survey method development		
a. Type and description of survey vehicle	Personal interview survey; 24-hour & seasonal dietary recall; fish/shellfish identification, portion, frequency, preparation, and harvest locations	The survey method and vehicle were developed in a technically defensible manner.
b. Collaboration and review	Survey was developed in collaboration with Washington DOH, Washington Dept of Ecology, ATSDR, University of Washington, EPA Region 10, Suquamish Tribal Fisheries Dept.	
c. Beta testing	Beta testing documented.	
2. Survey execution		
a. Establish & document execution standards	Execution of survey questionnaire documented with identifiable QA/QC procedures.	The survey vehicle was appropriately executed and documented; use of fish models was documented.
b. Document staff training	Training of personnel was conducted by trained Suquamish Tribe members.	
c. Fish/shellfish models used	Seafood models and a display booklet of seafood illustrations for multiple species were used to aid in identifying the amount of seafood consumed.	
3. Publication of results		
a. Where were results published? Are they clear and complete?	Fish/shellfish identification, portion, frequency, preparation and harvest locations documented & reported.	Suquamish Tribe publication with well-defined method, analysis of species consumed, clear data analysis and interpretation.
b. Methodology reported	The methodology used is clearly described and documented.	
c. Results tabulated & stated	Survey results are reported and summarized in a tabular format suitable for distributional descriptive statistics.	
d. Conclusions clearly reported	Conclusion reported with followup interviews for reliability and representation.	
e. Variability and uncertainty	Noted and documented with "outliers" identified.	
f. How is the potential for bias addressed?	The possibility for bias in the survey methodology is recognized and discussed.	
4. Applicability and utility for regulatory decision making		
a. Representation of target population	Included range of different rates for enrolled Suquamish Tribe members.	This survey meets the standards of relevance, applicability, and utility and is appropriate for use in regulatory decision making.
b. Currency of information	The survey was conducted in 1999; more recently, the consumption estimates were used by Oregon DEQ for developing water quality standards (2011).	
c. Sufficiency of data	The fish-consumption estimates are sufficient to provide descriptive statistics for defined distributions and percentiles for Suquamish Tribal population.	
5. Overall technical suitability for regulatory decision making		
a. Range of technical defensibility	Technically defensible dietary survey of the Suquamish Indian Tribe.	The survey is technically defensible
b. Appropriateness for use in risk-based standards	The data is sufficient to provide distribution and percentile estimates of fish consumption as required for risk-based decision making.	
Reference: The Suquamish Tribe. 2000. Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region. The Suquamish Tribe. 15838 Sandy Hook Road, Post Office box 498, Suquamish, WA 98392.		

## Asian and Pacific Islanders

An API seafood consumption study was conducted in King County, Washington, to obtain information on consumption rates, species and seafood parts consumed, and preparation methods for first- or second-generation members of the API community.<sup>99</sup> Survey participants were API seafood consumers 18 years or older. The study was conducted in three phases:

- Phase I: Identify target API ethnic groups and develop appropriate questionnaires in the language required to administer the questionnaire to each API ethnic group.
- Phase II: Characterize seafood consumption for ten API ethnic groups within the King County study area<sup>100</sup>
- Phase III: Develop culturally appropriate health messages on risks related to seafood consumption and disseminate to API community

Of the 202 respondents, 89 percent were first API generation (born outside the United States). API participants were interviewed by trained representatives from each of the 10 API ethnic communities represented and asked to report on the number of annual servings and portion size of the servings. Participants reported their own body weights with results reported as grams per kilogram per day. Because the survey was based on dietary recall, the authors selected 20 API respondents to interview a second time, to assess the reliability of the responses. The results suggest that the estimated consumption rates are reliable for the API community study area.

Survey results indicate that shellfish were consumed more by the API community than any other group of fish. More than 75 percent of the respondents consumed shrimp, crab, and squid. Salmon and tuna were the most frequently consumed finfish. For all fish groups, 79 to 97 percent of the seafood consumed came from either groceries/street vendors or restaurants. Japanese consume a greater percentage of finfish than shellfish (52 percent), while Vietnamese consume more shellfish (50 percent). The mean and median consumption rates for all seafood combined for the 10 API ethnic groups were 1.9 grams/kg body weight (bw)/day and 1.4 grams/kg bw/day, respectively. The average shellfish consumption rate for the API community was 0.87 grams/kg bw/day. The API community consumed more shellfish than all of the combined categories of finfish consumed (average finfish consumption is 0.82 grams/kg bw/day).

Below are weight-adjusted survey results for API adult fish consumers:

	Number of Adults Surveyed	Descriptive Statistics (g/day)					
		Mean	Median	Percentiles			
				75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	99 <sup>th</sup>
Asian & Pacific Islanders	202	117	78	139	236	306	-

<sup>99</sup> Sechena, R., C. Nakano, S. Liao, N. Polissar, R. Lorenzana, S. Truong, and R. Fenske. 1999. Asian and Pacific Islander Seafood Consumption Study in King County, Washington. EPA 910/R-99-003. May 1999. <http://www.epa.gov/r10earth/offices/oea/risk/a&pi.pdf>

<sup>100</sup> The 10 API ethnic groups are Cambodian, Chinese, Filipino, Hmong, Japanese, Korean, Laotian, Mien, Samoan, and Vietnamese.

*Technical defensibility:* The 1999 survey of King County Asian and Pacific Islanders is relevant to Washington and satisfies measures of technical defensibility.

**Table 20. Asian and Pacific Islander Seafood Consumption Study**

Survey Author: Sechena et al., 1999

Metric	Observations & Comments	Evaluation
1. Survey method development		
a. Type and description of survey vehicle	Personal interview survey; 24-hour dietary recall; conducted in three phases	The survey method and vehicle were developed in a technically defensible manner.
b. Collaboration and review	Survey was developed in collaboration with a Community Steering Committee (representatives of the Asian/Pacific Islander community, Washington DOH, Washington Dept of Ecology, EPA Region 10, University of Washington, Seattle Refugee Federation Service Center)	
c. Beta testing	The testing of the survey was conducted in phases with followup re-interviews to assess reliability of responses.	
2. Survey execution		
a. Establish & document execution standards	Seafood consumption studies for 10 API groups in King County, Washington. Technical execution guided by Community Steering, Technical, & Advisory Committees.	The survey was appropriately executed and documented; use of fish models was documented.
b. Document staff training	Trained bilingual interviewers from API community.	
c. Fish/shellfish models used	Seafood models were used to represent approximate portion sizes.	
3. Publication of results		
a. Where were results published? Are they clear and complete?	Information on types of seafood consumed, source of seafood, preparation methods, frequency & portion size consumed, demographic information clearly reported.	Robust analysis & evaluation of API community fish consumption habits and patterns
b. Methodology reported	Phase II (fish consumption) followed from identification target API populations with ethnic and language specific questionnaires.	
c. Results tabulated & stated	Tabulated species-specific consumption across 10 different API ethnic populations; included food preparation methods.	
d. Conclusions clearly reported	Conclusions clearly reported with followup interviews.	
e. Variability and uncertainty	Variability and uncertainty were qualitatively recognized and noted.	
f. How is the potential for bias addressed?	The possibility for bias in the survey methodology is recognized and discussed.	
4. Applicability and utility for regulatory decision making		
a. Representation of target population	The survey included a range of different API ethnic groups to evaluate consumption representative of API population.	This survey meets the standards of relevance, applicability, and utility and is appropriate for use in regulatory decision making
b. Currency of information	The survey was conducted in 1999; more recently, the consumption estimates were used by Oregon DEQ in developing water quality standards (2011).	
c. Sufficiency of data	The consumption estimates are sufficient to provide descriptive statistics for defined distributions and percentiles for different API populations	
5. Overall technical suitability for regulatory decision making		
a. Range of technical defensibility	Technically defensible dietary survey of API populations in King County, Washington.	Ecology concludes the survey is technically defensible.
b. Appropriateness for use in risk-based standards	The data is sufficient to provide distribution and percentile estimates of fish consumption as required for risk-based decision making.	
Reference: Sechena, R., Nakano, C., Liao, S., Polissar, N., Lorenzana, R., Truong, S., Fenske, R., 1999. Asian and Pacific Islander Seafood Consumption Study in King County, WA. U.S. Environmental Protection Agency, Region 10, Seattle, Washington, EPA/910/R-99-003.		

## Estimated United States per capita fish consumption

The EPA 2002 national estimates for fish consumption are based on analysis of the U.S. Department of Agriculture's (USDA) 1994-96 *Continuing Survey of Food Intakes by Individuals* (CSFII) and its 1998 *Children's Supplement*.<sup>101</sup> (These USDA reports are collectively referred to as CSFII 1994–1996, 1998).

The USDA surveys were designed to provide estimates of food consumption across the United States, and were conducted in all 50 states and Washington, D.C. They provide data for federal activities related to the nutritional status of the U.S. population.

Over 20,000 survey participants provided two nonconsecutive days of dietary data. The 24-hour dietary recall survey was administered over a period of 4 years. (The survey was designed so that the second interview occurred three to ten days after the first interview but not on the same day of the week.)

The CSFII was conducted by interviewing respondents according to a stratified design that accounted for geographic location, degree of urbanization, and socioeconomic status. Eligibility for the survey was limited to households with gross incomes at or less than 130 percent of the federal poverty guidelines. Survey weights were assigned to this data set to make it representative of the U.S. populations. As noted by the Oregon DEQ Human Health Focus Group Report:<sup>102</sup>

“Because of the extraordinarily large survey population and the fact that individuals were chosen to statistically represent overall U.S. populations this data set provides a valuable context for Pacific Northwest surveys.”<sup>103</sup>

CSFII is the primary source of food consumption data used in dietary risk assessments. It is well suited to national level dietary risk assessments because it is statistically designed to sample individuals of all ages and major ethnic subgroups to reflect various demographics. CSFII is statistically designed so that the national estimate of consumption is not biased by seasons of the year or regions of the country.<sup>104</sup> The CSFII may be considered a variation of the dietary market basket survey approach but with a larger scale and more sophisticated methodological design and execution.

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<sup>101</sup> U.S. Environmental Protection Agency. Estimated Per Capita Fish Consumption in the United States. EPA-821-C-02-003. August 2002. [http://www.epa.gov/waterscience/fish/consumption\\_report.pdf](http://www.epa.gov/waterscience/fish/consumption_report.pdf)

<sup>102</sup> Oregon DEQ, Human Health Focus Group Report—Oregon Fish and Shellfish Consumption Rate Project Report, June 2008. Pages 15-16.

<sup>103</sup> The Oregon DEQ Human Health Focus Group Report further notes: “Since the goal of the USDA CSFII surveys was to represent the diet of all people (per capita) in the United States, the data included people who eat fish (consumers) and those who don't eat fish (non-consumers). Including non-consumer data in a fish consumption rate can result in misleadingly low fish consumption rates. In addition to report the per capita fish consumption rates, [EPA (2002)] considered it appropriate to report the data for consumers only as well as the combined consumer and non-consumer data.”

<sup>104</sup> U.S. EPA. General Principles for Performing Aggregate Exposure and Risk Assessments. Office of Pesticide Programs. November 28, 2001. Web location: <http://www.epa.gov/oppead1/trac/science/aggregate.pdf>

## Additional fish consumption rate information evaluated by Ecology

Ecology considered a range of other related information. Although not all this information was specifically used in deriving a default fish consumption rate, it provided information on resources (Table 21), including historical information about use of resources and related fish consumption. This evaluation helped establish both a range and context for how fish consumption rates are used in Washington.

**Table 21. Fish Consumption Information Relevant to Washington and Considered by Ecology**

Tribal Surveys	Description
A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin (CRITFC, 1994)	Fish consumption habits & patterns of selected Native American tribes that reside and harvest fish in the Columbia River Basin. Includes Yakama and Umatilla tribes from Washington; Nez Perce and Warm Springs tribes from Oregon State.
A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region (Toy et al., 1996)	Puget Sound regional survey for two tribes. Provides information on both finfish and shellfish consumption
Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservations, Puget Sound Region (Suquamish, 2000)	Puget Sound regional survey for two tribes. Provides information on both finfish and shellfish consumption
Survey of Asian and Pacific Islander	
Asian and Pacific Islander Seafood Consumption Study (Sechena et al. 1999)	King County specific fish consumption estimates for Asian and Pacific Islanders. Survey information has been used by EPA Region 10 to estimate rates for Asian and Pacific Islander for other Puget Sound areas
U.S. General Population	
Estimated Per Capita Fish Consumption in the United States (EPA, 2002)	Includes fish consumers & nonconsumers. (This data was used by Oregon DEQ to estimate the percent of fish consumers and nonconsumers in Oregon.)
State Assessments, Evaluations, and Advisories	
Washington State Department of Health Fish Advisories	Various water body-specific fish consumption rates. DOH advisories provide information on fish meals that should be avoided or can be safely eaten for analytically determined contaminant levels in fish tissue.
Lower Duwamish Waterway Baseline Human Health Risk Assessment <sup>105</sup>	Provides fish consumption information based on Puget Sound surveys & EPA Region 10 Framework. Develops sediment cleanup standards based on tribal RME scenarios.
Lower Elwha Klallam Tribe/Port Angeles <sup>106</sup>	In collaboration with Ecology and using the EPA Region 10 framework developed tribal fish consumption rate. Cleanup standards are based on a tribal RME.
Lake Roosevelt, DOH <sup>107</sup>	DOH in cooperation with the Spokane Tribe, water body- and angler-specific creel survey; 42 fish meals/year; assuming 8 oz meal. This is approximately 26 g/day.
Sinclair Inlet Bremerton Naval Complex <sup>108</sup>	Cleanup standards based on Suquamish Tribe adult and children fish/shellfish ingestion rates and recreational sport fishers. (See Appendix B.)
Lake Whatcom, DOH <sup>109</sup>	Provided estimated species-specific fish meals sizes for commonly caught and consumed Lake Whatcom fish species (crayfish, cutthroat trout, kokanee, yellow perch, smallmouth bass) with median rates in grams/meal; from low (crayfish) of 24 g/meal and high (smallmouth bass) of 220 g/meal
Rhone-Poulenc <sup>110</sup>	Cleanup standards based on Tulalip tribal fish consumption and Asian and Pacific Islander seafood consumption. Range of fish consumption rates referred to and documented in Lower Duwamish Waterway Human Health Risk Assessment.
South Aberdeen-Cosmopolis Area <sup>111</sup>	Chinook, coho, chum; anadromous steelhead and cutthroat trout commonly found and available for harvest. Evaluates fish habitat and recommends habitat restoration and enhancement.

<sup>105</sup> U.S. Environmental Protection Agency Region 10 and Washington State Department of Ecology. Lower Duwamish Waterway Remedial Investigation. Appendix B: Baseline Human Health Risk Assessment. Final. November 12, 2007.

<sup>106</sup> Lower Elwha Klallam Tribal Publications. Local Seafood and Lower Elwha Klallam Tribal Health, May 30, 2007; and Lower Elwha Klallam Tribe Fish Consumption Rate, Additional Data, February 10, 2008.

<sup>107</sup> Washington Department of Health. Consumption Patterns of Anglers Who Frequently Fish Lake Roosevelt. September 1997

<sup>108</sup> Naval Facilities Engineering Command. Technical Memorandum: Human Health Risk Evaluation of Mercury in Sinclair Inlet Seafood, OU B Marine. Bremerton Naval Complex. Final 12 August 2010.

<sup>109</sup> Washington Department of Health. Data Report Lake Whatcom Residential and Angler Fish Consumption Survey. April 2001.

<sup>110</sup> U.S. Environmental Protection Agency, Region 10. Statement of Basis For Remedy Selection and Corrective Action Complete Without Controls Determination at Rhone-Poulenc, Inc., East Parcel. EPA ID # WAD 00928 2302, Administrative Order on Consent 1091-11-20-3008(h). November 2006.

<sup>111</sup> U.S. Department of the Interior, Fish and Wildlife Service. Habitat Quality and Fish Usage of Five Chehalis River Tributaries in the South Aberdeen-Cosmopolis Area. October 1994.

Tribal Surveys	Description
Naval Base Kitsap – Keyport, Washington <sup>112</sup>	Based on Suquamish Tribe shellfish (clams, mussels, crabs, oysters) consumption rate. Based on U.S. general population rate 54 gpd to Suquamish rate 632 gpd for clams.
Oakland Bay, Shelton <sup>113</sup>	Water body-specific evaluation. A range of shellfish consumption rates used, 17.5, 60, 175, 260 gpd; based in part on Squaxin Island tribal consultations.
Umatilla Tribal Water Quality Standard <sup>114</sup>	Consumption rate of 389 gpd approved by EPA Feb. 2010. (Lummi Nation, Shoshone-Bannock Tribe and the Swinomish Tribe are eligible to adopt tribal water quality for their respective reservations.)
Lake Washington <sup>115</sup>	Anglers rate 10.8 gpd; angler 95 <sup>th</sup> percentile 30.2 gpd; children anglers 9.5 gpd with 95 <sup>th</sup> percentile 86.2 gpd. Allowable meal limits determined for northern pikeminnow, yellow perch, cutthroat trout, sockeye salmon.

Table 22 on page 60 summarizes the information considered and evaluated by Ecology. (See also Appendix B.)

## Variability and uncertainty

The measures of technical defensibility presented in this chapter relied on EPA’s examination of different survey methodologies.

EPA examined different survey methodologies, important methodological considerations for fish consumption survey design, selection of respondents, quality assurance, and statistical analysis.<sup>116</sup> Additional EPA guidance has been provided for fish and wildlife consumption surveys that thoroughly examine survey instrument design, execution, and analysis.<sup>117</sup>

In the context of the reviews and guidance documents on survey design methodologies and the execution and analysis of survey results, different fish consumption rates have been reported and used by federal and state agencies. These differences may result from a variety of factors associated with study design and data analysis from various surveys.

When survey information for a specific local fish-consuming population is not available, the assessor must select a reasonable surrogate population and default rates from applicable surveys (if available). EPA Region – 10 has developed guidance that addresses this situation, and Ecology has employed this guidance to derive fish consumption rate based on applicable surrogate population characteristics, fish/shellfish habitat characteristics, and fish/shellfish abundance characteristics.<sup>118</sup> (See Appendix D for a description of the EPA Region 10 Framework.)

Numerous types of survey methods have been used to estimate fish consumption rates. Each type survey has inherent biases, strengths, and weaknesses that may contribute to variable results

<sup>112</sup>ATSDR Health Consultation. Naval Base Kitsap, Keyport, Health Consultation, EPA Facility No. WA1170023419. September 15, 2009.

<sup>113</sup> WA DOH Health Consultation. Evaluation of Dioxins in Shellfish from the Oakland Bay Site Shelton, Mason County, WA. July 27, 2010.

<sup>114</sup> Tribal Water Quality Standards in the Pacific Northwest and Alaska. U.S. EPA Region 10 at: <http://yosemite.epa.gov/r10/water.nsf/Water+Quality+Standards/Tribal+WQS+Inv>.

<sup>115</sup> Washington Department of Health. Final Report, Evaluation of Contaminants in Fish from Lake Washington, King County, Washington. September 2004.

<sup>116</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

<sup>117</sup> U.S. Environmental Protection Agency. Guidance for Conducting Fish and Wildlife Consumption Surveys. EPA-823-B-98-007. November 1998.

<sup>118</sup> U.S. Environmental Protection Agency, EPA Region 10 Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia, August 2007.

demonstrated across different surveys. These strengths and weaknesses have been considered by Ecology when evaluating the fish consumption rates.<sup>119,120</sup> It should be noted that regulatory policies that influence the initial stages of planning a survey will influence the nature of the results and conclusions reached. Furthermore, policy choices may not be consistent across various federal and state agencies and academic institutions.

Resource limitations and differences in objectives influence the survey design and execution of the survey vehicle. For regulatory risk management decisions, knowledge of the objectives of a survey, how the survey was conducted, and how the survey data was evaluated can be used to assess the reliability of the results, providing information about whether the results are applicable to a particular exposure scenario of interest.

### **Factors that contribute to variability and uncertainty**

A number of factors may contribute to potential sources of variability and uncertainty in fish and shellfish consumption survey results.<sup>121</sup>

*Target populations and characteristics of populations.* Different population groups may express different fish consumption rates. Recognizing differences between characterizing exposures of whole populations and estimating exposure to contaminants in actual consumers of fish is a critical distinction. For example, Oregon's Human Health Focus Group made the clear distinction between per capita fish consumption based on consumers and nonconsumers of fish. Often, populations that are high fish consumers are relatively small, with these consumers represented by extreme upper percentiles in a distribution defined by both consumers and nonconsumers of fish. Hence, using either per capita estimates or a consumption rate derived from a low percentile of the consumption distribution would not accurately estimate contaminant exposure.

*Differences in terminology, definitions, and design.* Terminology across different fish consumption surveys may be highly variable. A lack of a consistent terminology can contribute to variability and uncertainty. For example, *shellfish* usually refers to aquatic invertebrate organisms with a shell. Clams and oysters are easily identified as shellfish. However, selected aquatic animals (squid) have evolved such that the shell has become internal and/or reduced, while in others, the shell has disappeared (octopus). Furthermore, crustaceans have exoskeletons instead of true shells.

Seafood consumption may include fish and/or shellfish obtained from a variety of sources. Surveys may not differentiate the sources of the fish and/or shellfish. Indeed, some surveys may consider consumption of fish harvested from a single water body (e.g., Commencement Bay) while other studies determine rates for fish consumption from multiple water bodies. Also, consumption rates reported in different studies may or may not distinguish between consumption of marine, estuarine, and freshwater fish and shellfish. These differences and their contributions to variability were summarized by Ebert et al., 1994. This study noted that the consumption rate of an individual

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<sup>119</sup> Ebert, Ellen, S., Paul Price, and Russell E. Keenan. 1994. Selection of Fish Consumption Estimates For Use In the Regulatory Process. *Journal of Exposure Analysis and Environmental Epidemiology* 4:373-393.

<sup>120</sup> U.S. Environmental Protection Agency. Consumption Surveys For Fish and Shellfish. A Review and Analysis of Survey Methods. EPA 822/R-92-001. February 1992.

<sup>121</sup> Ebert ES, Price PS, Keenan RE (1994) Selection of fish consumption estimates for use in the regulatory process. *Journal of Exposure Analysis and Environmental Epidemiology* 4: 373-393.

comprises the sum of the rates from different sources. Estimates may vary substantially depending on how these different sources are evaluated.<sup>122</sup>

*Types of data and methods of collection.* Ecology has recognized different methods to collect fish consumption data. For example, data collected from creel surveys involve interviewing anglers at fishing locations to provide water-body specific data about fishing frequency, fish species, and sizes caught and/or consumed. Hence, the creel survey method may only be representative of specific seasons or targeted species. Creel surveys, like other surveys methods, are subject to biases in that poor catches or catches below legal size limits or above total allowable limits may not be reported. Ecology's measures of technical defensibility account for variability across relevant studies and the survey methods employed. An important element that Ecology considered in the survey design is whether a survey adequately represents its target population. A number of factors can affect the ability of a survey design to reach the target population and represent it accurately. Elements to consider for specific target populations include literacy, language, and cultural sensitivities.

*Study duration.* Surveys designed to cover specific seasons or time periods may be subject to biases. Data obtained from single days are subject to potential biases from the effects of the day of the week or seasonal variations. Consumption data obtained on consecutive days may be biased due to the consumer correlation with the fish consumed on adjacent days. The timing of the survey may or may not account for seasonal variations. Recall surveys may suffer from recall bias which may either overestimate or underestimate fish consumption. Contributions to recall bias include how commonly or frequently the fish is consumed, actual time frames that are covered in the survey, and survey methods (such as the use of fish models) to enhance memory. These factors and other noted by Ebert et al 1994 may contribute to bias and hence variability in fish consumption rates.<sup>123</sup>

*Regional variations.* Fish consumption surveys conducted across the U.S. have shown regional variation including differences for coastal areas compared with inland areas, seasonal differences in available species, and regional preferences for certain types of fish and/or shellfish. Ebert et al., 1994 further noted that local differences in climate, fishing regulations, accessibility to fisheries, and availability of fish contribute to the variability in reported fish consumption rates. Comparing the results of different survey conducted in different geographic locations, with different methodologies, time frames, or other different survey design elements that are not comparable makes the interpretation of differences in fish consumption very problematic.

*Data analysis and statistical considerations.* Ecology has noted that careful definition of the target population is essential to reduce bias in the survey results. To avoid characterizing the consumption for a population that is not at risk from consuming contaminated fish, surveys are designed to evaluate consumers of fish only. Various statistical techniques have been described to analyze fish consumption data. For example, different methods of treating missing data or nonresponse data may contribute to bias. Defining subgroups within a larger population (stratification) differently can affect survey results and introduce different levels of bias. An important element of survey design is how well the survey (sample population represents the

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<sup>122</sup> IBID

<sup>123</sup> Ebert ES, Price PS, Keenan RE (1994) Selection of fish consumption estimates for use in the regulatory process. *Journal of Exposure Analysis and Environmental Epidemiology* 4: 373-393.



selected target population or population of concern. Statistical methods should consider sampling rate, differences in sampling days, and other factors that may influence the results. The fish consumption rates for a fish-consuming population should be sufficiently characterized to provide a population distribution such as the median and upper percentiles (90<sup>th</sup> or 95<sup>th</sup> percentile) or bounding estimates (99<sup>th</sup> or 99.9<sup>th</sup> percentile). It is essential to understand how these distributions were derived. Distributions derived from consumers and nonconsumers of fish have different meanings and applications.

*Summary of Potential Bias/Variability.* Contributors to bias and hence different levels of variability and uncertainty are associated with a variety of factors. Some of these factors include:

- Survey methodology and design and execution;
- Response rates, literacy, language barriers, and cultural sensitivities;
- Coding errors, interviewer bias, different efforts by interviewers or respondents, cultural differences in interpretation, and recall bias;
- The working and sequencing of questions can affect responses;
- Accurately representing the target population;
- Unknown factors such as number of consumer in a household or amount of fish obtained and eaten;
- Different methods of analysis may yield different fish consumption estimates from the same dataset.

Specific for the Pacific Northwest fish-consuming populations, the EPA Region 10 framework highlighted uncertainties inherent with the application of the framework. Most of these uncertainties are not just related to the application of the EPA Region 10 Framework but are associated with the uncertainties characteristic of fish consumption related information. Some of these uncertainties include:

- Use of a tribe-specific fish and shellfish consumption study as a surrogate for another Tribe's consumption rate
- The degree to which traditional lifeways or subsistence fish and shellfish consumer are included in existing tribe consumption studies
- Percentage of consumed fish and shellfish assumed to be adversely affected by site-related contamination
- Exclusion or inclusion of salmon – the exclusion or inclusion of risks associated with salmon consumption on a contaminant/site-specific basis
- Use of national fish/shellfish consumption data to characterize Washington fish-consuming populations
- Consideration of vulnerable individuals and exposures to chemicals with selective toxicological endpoints
- Use of uncooked fish/shellfish rates as representative of weight of fish/shellfish consumed

- Exposure to contaminant in fish/shellfish other than by the consumption of contaminated fish

## Summary and conclusions

Ecology reviewed fish/shellfish dietary survey information and fish consumption related information relevant to fish-consuming populations for Washington.

Ecology identified four surveys as appropriate for use in establishing a technically defensible default fish consumption rate (or rates) for use in Washington:

- Two Native American fish/shellfish dietary surveys for three tribal populations in Puget Sound
- One Native American finfish dietary survey for four tribal populations in and around the Columbia River basin
- One Asian and Pacific Islander fish/shellfish dietary survey from King County

These surveys provide fish and shellfish dietary information for fish-consuming populations for Washington and identify and quantify consumption habits.

The dietary survey methodologies employed are well documented, provide quantifiable dietary information useful for risk-based decision making, and include sufficient information to provide percentile fish consumption estimates.

Ecology also considers as relevant the 2002 EPA estimate of per capita fish consumption for the United States. This national data provides context for establishing a default rate protective of Washington fish consumers. Although this data comes from a survey considerably different in type and scope than surveys conducted to identify local fish consumption habits, the national data for fish consumers provides that is generally compatible with other information about high fish consumers. That is, the national information supports conclusions about high fish consumers.

Ecology believes that these surveys provide sufficient information about fish consumption in Washington and can be used in establishing a default fish consumption rate (or range of rates) protective of high fish consumers and applicable for regulatory decision making.

**Table 22. Summary of Fish Consumption Rate Surveys Considered by Ecology**

	Population Surveyed	Type of Fish Included in Survey	Number of Adults Surveyed	Descriptive Statistics (g/day)					
				Mean	Median	Percentiles			
						75th	90th	95th	99th
Data from dietary recall surveys	Tulalip Tribe	* Finfish (anadromous & estuarine) * Shellfish	73	72	45	85	186	244	312
	Suquamish Tribe	* Finfish (anadromous & estuarine) * Shellfish	284	214	132	-	489	-	-
	Squaxin Island Tribe	* Finfish (anadromous & estuarine) * Shellfish	117	73	43	-	193	247	-
	Columbia River Tribes	* Finfish (anadromous & freshwater)	512	63	40	60	113	176	389
	Asian & Pacific Islanders	* Finfish (anadromous & estuarine) * Shellfish	202	117	78	139	236	306	-
EPA estimate	Fish consumers in the U.S. General Population <sup>124</sup>	* Finfish (anadromous, estuarine, marine, & freshwater) * Shellfish	2,585	127	99	-	248	334	519

Source: Adapted from Table 3, page 28, Human Health Focus Group Report, Oregon Fish and Shellfish Consumption Rate Project, Oregon Department of Environmental Quality, June 2008. Blank cells indicate data not available.  
Ecology considered values between the 90<sup>th</sup> and 95<sup>th</sup> percentile value. For the Suquamish data Ecology considered values between the mean and 90<sup>th</sup> percentile.

<sup>124</sup> The national per capita fish consumption data was collected using a methodology distinctly different than the five dietary recall surveys. It is included here for comparison purposes. It indicates that although the method of collecting the data differs, the results are generally consistent

# Chapter 5: Regulatory Context for Using Fish Consumption Rates

## Introduction

Ecology currently establishes water quality requirements (water quality standards, surface water cleanup standards, and sediment cleanup standards) based on protecting human health under both the MTCA and the Water Pollution Control Act.<sup>125</sup>

The fish consumption rate used to establish these requirements can make a significant difference in the stringency of the requirements. This chapter briefly summarizes the regulatory frameworks and policies of the:

- Model Toxics Control Act Cleanup Regulation<sup>126</sup>
- Sediment Management Standards
- Water Quality Standards for Surface Waters

The use of fish consumption rates by EPA and the Washington Department of Health is discussed, and fish consumption rates used in various regulatory contexts in Washington are provided.<sup>127</sup>

This chapter provides background information on the different approaches used in various regulatory contexts: MTCA provides a default fish consumption rate for use in setting surface water cleanup standards and includes the ability to set site-specific fish consumption rates if sufficient information exists; the Sediment Management Standards are silent on specifics of protecting human health from contaminated sediments; and the Water Quality Standards for Surface Waters use a fish consumption rate specified in the National Toxics Rule and acknowledged by EPA as not protective of human health. EPA Region 10 provides a framework for site-specific CERCLA cleanup decisions, and DOH issues health advisories based in part on fish consumption rates.

This report does **not** examine the implications or results of updating the fish consumption rates in these various regulations. This report is focused solely on the data available on fish consumption in the state of Washington. Other materials being prepared concurrently will examine in detail the policy considerations and implications.

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<sup>125</sup> 70.105D RCW and 90.48 RCW

<sup>126</sup> Work on updating the MTCA Cleanup Regulation is on hold pending Executive Order 10-06, suspending for one year non-essential rulemaking. November 2010.

<sup>127</sup> In this report the terms "rule" and "regulation" are used interchangeably and have the same meaning.

## The Model Toxics Control Act Cleanup regulation

The “reasonable maximum exposure” as defined in the MTCA Cleanup Regulation forms the basis for establishing cleanup levels protective of human health.

The MTCA Cleanup Regulation includes methods and policies for establishing cleanup standards.<sup>128</sup> MTCA cleanup standards are designed to protect both the general population and people who are more highly exposed and/or susceptible to the effects of hazardous substances (pregnant women, children, unborn children, etc.).<sup>129</sup> MTCA cleanup standards must be at least as stringent as applicable state and federal requirements (such as drinking water standards and surface water standards) and risk-based standards calculated using equations in the MTCA Cleanup Regulation.

Under MTCA, risk-based surface water cleanup levels (for carcinogenic risks) are calculated according to Figure 1 below. Key features of the MTCA equations include:

- Cleanup standards are generally based on an incremental cancer risk of one in one million and, for noncancer risks, a hazard quotient of one.
- Cleanup standards are generally calculated using toxicity values (cancer slope factors and reference doses) developed by the Environmental Protection Agency or other environmental agencies.
- Cleanup standards are based on estimates of a reasonable maximum exposure (RME).

$$CUL = \frac{(RISK * ABW * AT * UCF1 * UCF2)}{(CPF * FCR * FDF * ED * EF)}$$

Where:

CUL	=	Surface water cleanup standard (µg/L)
RISK	=	Acceptable cancer risk level (1 in 1,000,000) (unitless)
ABW	=	Average body weight during the exposure duration (70 kg)
AT	=	Averaging time (75 years)
UCF1	=	Unit conversion factor (1,000 µg/mg)
UCF2	=	Unit conversion factor (1,000 grams/liter)
CPF	=	Carcinogenic Potency Factor as specified in WAC 173-340-708(8) (kg-day/mg)
FCR	=	Fish consumption rate (54 grams/day)
FDF	=	Fish diet fraction (0.5) (unitless)
ED	=	Exposure duration (30 years)

**Figure 1. MTCA Surface Water Cleanup Standards (Carcinogenic Risk)**

<sup>128</sup> Chapter 173-304 WAC

<sup>129</sup> Washington State Department of Ecology, Concise Explanatory Statement, MTCA Cleanup Regulation, February 12, 2001, page 119.

## Reasonable Maximum Exposure defined under MTCA

The MTCA Cleanup Regulation defines the RME as “the highest exposure that is reasonably expected to occur at a site under current and potential future site use.”<sup>130</sup>

- The RME is designed to represent a high end (but not worst case) estimate of individual exposures.<sup>131</sup> It provides a conservative estimate that falls within a realistic range of exposures.<sup>132</sup> For example, the preamble to the National Oil and Hazardous Substances Pollution Contingency Plan includes the following guidance:

EPA defines “reasonable maximum” such that only potential exposure that are likely to occur will be included in the assessment of exposures. The Superfund program has always designed its remedies to be protective of all individuals and environmental receptors that may be exposed at a site; consequently, EPA believes it is important to include all reasonably expected exposures in its risk assessments...

- The RME is defined as reasonable because it is a product of several factors that are an appropriate mix of average and upper-bound estimates. RME estimates typically fall between the 90<sup>th</sup> and 99.9 percentile of the exposure distribution.<sup>133</sup>
- The RME takes into account both current and reasonably foreseeable future conditions.<sup>134</sup>

Under the current MTCA rule, surface water cleanup standards are established based on a default fish consumption rate of 54 grams/day.<sup>135</sup> This default parameter used in establishing surface water cleanup standards is based on a recreational angler exposure scenario developed by Ecology in the 1980s.

In 2008, Ecology asked the MTCA Science Advisory Board for advice on a site-specific fish consumption rate applicable to a cleanup action being conducted in the Port Angeles Harbor. The harbor is located within the usual and accustomed fishing area for the Lower Elwha Klallam Tribe.<sup>136</sup> The Board agreed with Ecology’s conclusion that the recreational default fish consumption rate currently used in MTCA rule does not represent a reasonable maximum exposure for Native American populations who typically eat higher amounts of fish and shellfish.

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<sup>130</sup> See WAC 173-340-708 (3) (b). CERCLA provides a similar definition “...the highest exposure that is reasonably expected to occur at a Superfund site...”

<sup>131</sup> The worst-case exposure represents an extreme set of exposure conditions, usually not observed in an actual population, which is the maximum possible exposure where everything that can plausibly happen to maximize exposure, happens. This is discussed in U.S. EPA Guidelines For Exposure Assessment, Federal Register Notice, Vol. 57, No. 104, May 1992, pages 22888-22938.

<sup>132</sup> U.S. Environmental Protection Agency. An Examination of EPA Risk Assessment Principles and Practices. EPA/100/B-04/0001. March 2004.

<sup>133</sup> *IBID.*

<sup>134</sup> Washington State Department of Ecology, 1991 Responsiveness Summary to the MTCA Cleanup Regulation.

<sup>135</sup> The fish diet fraction is defined under MTCA as the fraction of the fish consumed estimated to come from the site.

<sup>136</sup> MTCA Science Advisory Board (SAB) Meeting Notes for SAB Meetings held December 14, 2007, March 11<sup>th</sup> and June 2<sup>nd</sup>, 2008; Web location for SAB meeting notes: [http://www.ecy.wa.gov/programs/tcp/SAB/SAB\\_mtg\\_info/mtg\\_info.htm](http://www.ecy.wa.gov/programs/tcp/SAB/SAB_mtg_info/mtg_info.htm)

## Sediment management standards

The SMS were adopted in 1991 to implement Ecology's responsibilities to clean up contaminated sediments at hazardous waste sites under the Model Toxics Control Act.<sup>137</sup> Part V of the SMS rule establishes requirements for sediment cleanup standards; sediment cleanup actions conducted under a MTCA order, agreed order or consent decree must comply with requirements in both the SMS and the MTCA Cleanup Regulation.

The SMS at 173-204-570 WAC identifies the sediment cleanup objective as "no significant health threat to humans." No details are provided in the SMS to determine sediment cleanup levels that are protective of human health. However, because both MTCA and SMS rules apply, sediment cleanup standards protective of human health are based on the MTCA Cleanup Regulation using MTCA acceptable risk levels and the highest concentration of the following:

- Risk-based cleanup concentration for the most sensitive receptor
- Natural background concentration – a background concentration or background area not influenced by localized human activities
- Practical quantitation limit – lowest concentration that can be reliably measured within specified limits of precision and accuracy

Sediment cleanup levels protective of human health account for both potential contaminant bioaccumulation from contaminated sediments and the consumption of potentially contaminated fish. To derive most sediment cleanup levels protective of human health, recreational and tribal harvesting and consumption practices are considered by Ecology.

## Water quality standards

Washington's water quality standards for human health protection were issued to the state by EPA in 1992 (National Toxics Rule, 40CFR131.36), and further revised in 1999 (PCB criteria only). The human health-based Ambient Water Quality Criteria in the National Toxics Rule were calculated using a fish consumption rate of 6.5 g/day.

EPA completed the technical evaluations underlying the National Toxics Rule in the mid-1980s and early 1990s. Since then, EPA has revised their guidance for developing human health-based criteria (EPA, 2000) and currently recommends using a higher default fish consumption rate (17.5 grams/day developed for national use).

Local or state-specific data is sometimes more appropriate to use in criteria calculation if fish and shellfish consumers ingest amounts of tissue in excess of the national default value. Current studies of fish consumption in the Pacific Northwest show that fish and shellfish consumers in Washington eat substantially more than the national default of 17.5 grams/day, indicating that use of state-specific data should be considered as criteria are further examined.

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<sup>137</sup> Chapter 173-340 WAC

Ambient water quality criteria are established under Section 304(a) of the Clean Water Act of 1972 and are used by states and Indian tribes to establish water quality standards that provide a basis for controlling discharges or releases of pollutants.<sup>138</sup> Ambient water quality criteria do not reflect considerations of economic impacts or the technological feasibility of reducing chemical contaminant concentrations in ambient water.<sup>139</sup>

## EPA Region 10 Framework

The U.S. Environmental Protection Agency, Region 10 (EPA Region 10), has published a decision-making framework to derive fish/shellfish consumption rates to help support the cleanup of contaminated sites in Puget Sound and the Strait of Georgia up to the Canadian border.<sup>140</sup> (See also Appendix D.)

The framework was developed to aid decision making given limited site-specific seafood consumption information that could support regulatory cleanup decisions on hazardous waste sites located on tribal lands or within tribal fishing areas. The application of the EPA Region 10 Framework provides a consistent and protective approach to establishing fish consumption rates for fish-consuming populations.

The EPA Region 10 Framework identified a tiered information hierarchy of preferred data to be used:

- Fish/shellfish consumption surveys from local watershed representative of the population being addressed for a water body
- Fish/shellfish consumption surveys that reflect geography or population groups similar to those under evaluation
- National food consumption survey information
- Default values

The EPA Region 10 Framework uses the seafood consumption information from the Suquamish and the Tulalip Tribes to support the development of fish consumption rates for other fish (tribal) consuming populations.<sup>141</sup> The selection of the Suquamish or the Tulalip consumption information to be used as a surrogate for other tribal or fish-consuming populations is dependent on consideration of the following:

- Fish/shellfish abundance
- Fish/ shellfish habitat quality

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<sup>138</sup> Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health – Revised Methodology (2000). Fact Sheet: October 2000. <http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/health/methodology/factsheet.cfm>

<sup>139</sup> 1999 Aquatic Life Ambient Water Quality Criteria for Ammonia Update. Fact Sheet: December 1999 Update-Technical Version <http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/aqlife/pollutants/ammonia/Technical.cfm>

<sup>140</sup> U.S. EPA Region 10. Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia. U.S. Environmental Protection Agency, Region 10, Office of Environmental Assessment. August 2007

<sup>141</sup> Toy et al., 1996. Toy, K.A., Polissar, N.L., Liao, S., and Mittelstaedt, G.D., 1996. A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region. Tulalip Tribes, Department of Environment, 7615 Totem Beach Road, Marysville, WA 98271.



- Fish/shellfish habitat quantity
- Careful consultation with fish/shellfish tribal biologists to make an informed decision regarding the selection of the dataset
- Historical patterns of fish/shellfish abundance and habitat quality

Selection of the Suquamish Tribe's dataset is most applicable to cleanup sites with extensive intertidal habitat to sustain shellfish harvests. Selection of the Tulalip Tribe's dataset is most applicable where there is less shellfish habitat to sustain shellfish harvests. The EPA Region 10 Framework assumes all of the fish/shellfish harvested from the Puget Sound may be affected by site contaminants. Hence, unless there is site-specific information attributing salmon contaminant body burdens to site contaminants, salmon are included in the overall fish consumption rate.

Consistent with U.S. EPA regulatory policies, procedures, and guidance the fish consumption rates used in the EPA Region 10 Framework was based on the 95<sup>th</sup> percentile from the Suquamish or Tulalip consumption dataset (uncooked weight, harvested from Puget Sound). The fish consumption rates are categorized for various species: salmon, pelagic fish, bottom fish, and shellfish. The total fish/shellfish ingestion rates for the two tribes are adjusted to include only fish and shellfish harvested from Puget Sound.

The table below provides the Tulalip Tribe's fish consumption rate and percent of diet assumed by the species tabulated in the EPA Region 10 Framework. The total unadjusted fish/shellfish consumption rate for the Tulalip Tribe is 243 grams/day. The average Tulalip adult body weight used to derive the grams/day fish consumption rate was 81.8 kilograms.

**Table 23. Tulalip Tribe's Fish Consumption Rate (grams/day)**

Species Category	Fish Consumption Rate	Percent of diet
Salmon	96.4	49.7
Pelagic Fish	8.1	4.2
Bottom	7.5	3.9
Shellfish	81.9	42.2
Total Ingestion Rate w/ Salmon	194	100
Total Ingestion Rate w/o Salmon	98	

Adapted from Table B-1, EPA Region 10 Framework

The table below provides the Suquamish Tribe's fish consumption rate and percent of diet assumed by the species tabulated in the EPA Region 10 Framework. The total unadjusted fish/shellfish consumption rate for the Suquamish Tribe is 796 grams/day. The average Suquamish Tribe adult body weight used to derive the grams/day fish consumption rate was 79 kilograms.

**Table 24. Suquamish Tribe's Fish Consumption Rate (grams/day)**

Species Category	Fish Consumption Rate	Percent of diet
Salmon	183.5	23.9
Pelagic fish	56.0	7.3
Bottom	29.1	3.8
Shellfish	498.4	65
Total ingestion rate with salmon	766	100
Total ingestion rate without salmon	583	

Adapted from Table B-2, EPA Region 10 Framework

The EPA Region 10 Framework has been applied to support the cleanups of several Washington sites:

- The Lower Duwamish Waterway and associated sites along the waterway
- Port Angeles ITT Rayonier
- Puget Sound Naval Shipyard

## Regulatory use of fish consumption rate data by EPA

In 2002, EPA updated the *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health*. Based on the *Continuing Survey of Food Intakes by Individuals* (CSFII 1994-1996, 1998) EPA now recommends the following default fish consumption rates:<sup>142</sup>

General population	17.5 grams/day
Recreational fishers	17.5 grams/day
Subsistence fishers	142.4 grams/day

EPA default value for the general population and for recreational fishers of 17.5 grams/day reflects the 90<sup>th</sup> percentile values for freshwater and estuarine ingestion by adults from the USDA's CSFII Survey for the years 1994 to 1996.

## Washington State Department of Health fish advisories

DOH fish advisories provide information about how much fish or shellfish can be safely consumed. That is, answers to "How much fish can I safely consume?" depend on contaminant levels in commercial, sport, or subsistence caught fish.

To answer these questions, DOH utilizes guidelines outlined in EPA's *Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories Vol. 1-4* for assessing mercury, PCBs, and other contaminants to determine whether an advisory is warranted.<sup>143</sup> These guidelines provide a framework from which states build and develop state or regional fish advisories based on sound science and established risk assessment paradigms. Fish tissue evaluation involves several steps: risk assessment, risk management, and risk communication.

- *Risk assessment* involves calculating allowable meal limits based on known fish contaminant concentrations. These calculations are conducted for both noncancer and cancer endpoints using the appropriate reference dose (RfD) or cancer slope factor (CSF), if available. These initial calculations are the starting point for evaluating contaminant data to determine whether a fish advisory is warranted. Additionally, known or estimated consumption rates help determine the potential magnitude of exposure and highlight the sensitive groups or populations that may exist due to elevated consumption rates.

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<sup>142</sup> U.S. Environmental Protection Agency. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000). Office of Water. Office of Science and Technology. EPA-822-B-00-004. October 2000.

<sup>143</sup> National Guidance: *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories – Vol. 1-4*. <http://water.epa.gov/scitech/swguidance/fishshellfish/outreach/es.cfm>

- *Risk management* includes (but is not limited to) consideration of contaminant background concentrations, reduction in contaminant concentrations through preparation and cooking techniques, known health benefits from fish consumption, contaminant concentrations or health risks associated with replacement foods, and cultural importance of fish. Other considerations are possible health endpoints associated with a contaminant, strength or weaknesses of supporting toxicological or sampling data, and whether effects are transient or irreversible.
- *Risk communication* is the outreach component of the fish advisory. Interpretation of data from the risk assessment and risk management components drives how and when fish advisory recommendations are issued to the public, dependent on whether the message is targeted toward a sensitive group or a population or the general public. DOH's dual objective in messaging is how best to provide guidance to the public to increase fish consumption of fish low in contaminants to gain the benefits of eating fish while at the same time steering the public away from fish that have high levels of health- damaging contaminants.

At present, Washington State DOH has issued 14 fish consumption advisories, which include Puget Sound, and two state-wide mercury fish advisories. As EPA guidance recommends, DOH does not configure fish advisories based on a specific default fish consumption rate. DOH utilizes consumption rates for screening potential exposures and to estimate potential risks.

DOH has also developed the "Healthy Fish Guide" designed to increase public awareness of many commercial and recreational fish choices that exhibit low fish tissue contaminant concentrations. The guide also identifies fish that should be avoided due to high mercury or PCB levels, communicates the benefits of eating fish, and reminds consumers that eating fish at least two times a week is important for maintaining good health.<sup>144</sup>

DOH provides support documentation for all fish advisories issued throughout Washington. For example, the Lake Whatcom Fish Advisory issued by DOH in May 2001 has a companion support document, "Lake Whatcom Residential and Angler Fish Consumption Survey."<sup>145,146</sup>

Washington fish consumption advisories and companion support documents provide information on finfish and/or shellfish species, finfish and/or shellfish tissue contaminant levels, and fish consumption for anglers associated with the specific water body being evaluated. In addition, most DOH documents provide fish consumption information gathered from residents who live on or near the water body, from residential developments with access to the water body, or from shore or boat anglers.

Because information collected by DOH is specific to a particular water body and is based on creel surveys, most consumption data is not suitable or designed for the quantitative assessments that provide percentile distributions.

In addition, surface water and sediment cleanup standards developed by Ecology are designed to be health protective for unrestricted harvest of fish/shellfish and unrestricted consumption of

<sup>144</sup> Washington State Department of Health Healthy Fish Guide. <http://www.doh.wa.gov/ehp/oehas/fish/fishchart.htm>

<sup>145</sup> Washington State Department of Health. Data Report: Lake Whatcom Residential and Angler Fish Consumption Survey. April 2001.

<sup>146</sup> Washington Department of Health. Lake Whatcom Fish Advisory. May 2001

fish/shellfish. DOH health advisories provide fish consumers with advice on the number of fish meals that can be safely eaten on a weekly or monthly basis and/or fish to be avoided.

Despite these programmatic differences, Ecology acknowledges that DOH fish advisories provide important information on fish/shellfish species and consumption for different water bodies throughout Washington. (Information from selected DOH advisories is provided below.)

## Examples of fish consumption rates used in various regulatory contexts

A range of fish consumption rates have been used in a regulatory context both for establishing cleanup standards and for developing tribal water quality standards. The lists included here are intended to demonstrate the wide range used in Washington regulatory decisions. This variability has contributed to Ecology proposing a default value for use in regulatory decision making.

Although site-specific data may be available and appropriate for certain situations, Ecology believes that many cleanup decisions can be based on a default fish consumption rate and will result in health-protective cleanup standards.

**Table 25. Examples of Fish Consumption Rates and Regulatory Context**

Rate (grams/day)	Context
6.5	Rate used for the National Toxics Rule, Ambient Water Quality Criteria, from national nontribal food surveys
17.5	Rate used for current Ambient Water Quality Criteria for general nontribal populations
54	MTCA default fish consumption rate based on recreational exposure. Note: MTCA specifies a fish diet fraction = 0.5.
57	Asian-Pacific Islander, fish diet fraction 1.0, body weight 63 kg, lower Duwamish
~80	Rates used by Colville Tribe to develop water quality standards
142	EPA proposed average for tribal subsistence fishers-freshwater & estuarine not marine waters. Value used by Oregon DEQ in their bioaccumulation guidance.
140-148	Rates used by Puyallup and Port Gamble Tribes to develop water quality standards.
173	Bellingham Bay – Whatcom Waterway Cleanup Action Plan, 90 <sup>th</sup> percentile value from Tulalip and Squaxin Tribes for crab, bottomfish, clams and mussels (70 g/day) + additional consumption of salmonid, pelagic and freshwater fish.
175	Oregon DEQ fish consumption rate based on CRITFC data (approximates the 95 <sup>th</sup> percentile) to establish human health water quality criteria.
194	Tulalip tribal rate applied to lower Duwamish w/o salmon effective rate is 97.5, body weight 79 kg, fish diet fraction 1.0
389	99 <sup>th</sup> percentile from CRITFC survey & used by Umatillas Tribes for Tribal Water Quality Standards
540	Average for traditional Umatilla tribal fishing families
583	Port Angeles cleanup, Lower Elwha Klallam rate based on Suquamish data, body weight 79 kg, fish diet fraction 1.0
620	Hanford Nuclear Reservation, applied within 20 miles of a major fishing river, 1.0 fish diet fraction, 70 kg body weight. This is equal to the Boldt decision historical rate for Columbia River mainstem
650	Yakama tribal members using Columbia R. for resident & anadromous fish
1000	Pre-dam rate for Columbia R. Plateau Tribes

**Table 26. EPA Region 10 Tribal Fish Consumption Rates Related to Water Quality Standards<sup>147</sup>**

Fish Consumption Rate grams/day	Tribe	Status of WQS
EPA Promulgated Water Quality Standards (WQS)		
Narrative Criterion	Colville Tribe	No fish consumption rate revisions by EPA at this time, tribally adopted WQS (no toxics criteria) (6.5 g/day--EPA AWQC 1989 (per e-mail from EPA, S.Brough to Ecology, C. Niemi, 2/25/08))
Tribes with EPA Approved "Treated As State" (TAS) and EPA Approved WQS		
6.5	Chehalis	TAS Approved – 2/03/1997 No revisions to the FCR at this time (EPA's National Toxics Rule, 57 Fed. Register 60848 (1992))
17.5	Kalispel	TAS Approved – 6/24/2004 No revisions to the FCR at this time (EPA's National Toxics Rule & 2002 AWQC Update)
142.4	Makah	TAS Approved – 9/29/2006 No revisions to the FCR at this time ( <i>EPA Default Subsistence Rate</i> )
142.4	Lummi	TAS Approved – 9/30/2008 No revisions to the FCR at this time ( <i>EPA Default Subsistence Rate</i> )
142.4	Port Gamble S'Klallam	TAS Approved – 9/27/2005 No revisions to the FCR at this time ( <i>EPA Default Subsistence Rate</i> )
6.5	Puyallup	TAS Approved – 10/31/1994 Tribe conducted public review – proposed 142.4 g/day (EPA's National Toxics Rule, 57 Fed. Register 60848 (1992))
86.3	Spokane	TAS Approved – 4/22/2003 Tribe adopted 865 g/day Submitted to EPA April 2010 (63 Fed. Register 43756 (1998)) <sup>148</sup>
389	Umatilla	TAS Approved – 2/11/2010 No revisions to the FCR at this time (The Columbia Basin Fish & Wildlife News Bulletin <sup>149</sup> )
170	Warm Springs	TAS Approved – 7/20/2006 No revisions to the FCR at this time ( <i>CRITFC Survey</i> )
Tribes with EPA Approved "Treated As State" (TAS) and Tribally Adopted WQS		
66	Tulalip	WQS are tribally adopted but have not been submitted to EPA
Tribes with EPA Approved "Treated As State" (TAS) and in the process of Developing WQS		
17.5	Coeur d' Alene	Submitted to EPA June 2010 (EPA's National Toxics Rule & 2002 AWQC Update)
Considering 214	Swinomish	Tribe preparing for public review
Considering 17.5	Shoshone-Bannock	Tribe preparing for public review summer 2010 (EPA's National Toxics Rule & 2002 AWQC Update)
Tribes Developing WQS and "Treated As State" (TAS)		
142.4	Lower Elwha	WQS are tribally adopted, tribe is developing TAS application ( <i>EPA Default Subsistence Rate</i> )
Considering 17.5	Skokomish	Tribe is developing TAS application
142.4	Yakama	WQS are tribally adopted (EPA Default Subsistence Rate)

<sup>147</sup> Information Provided at the EPA / Washington Tribes Annual Workshop. "Fish Consumption Rates: Effects on Tribes and Their Traditional Food." Held June 16, 2010 at the Suquamish Community House Co-Sponsored by the Northwest Indian Fisheries Commission and EPA Region 10.

<sup>148</sup> 63 Fed. Register 43768-43769(1998): The AWQC default fish consumption value of 17.80 grams/day is for the general adult population, which represents the 90<sup>th</sup> percentile consumption rate for the entire adult population and approximates the average consumption rate for sport anglers, nationally. The 86.3 grams/day default value for subsistence fishers/minority anglers, represents the 99<sup>th</sup> percentile consumption rate for the general populations and falls within the range of averages for subsistence/minority anglers.

<sup>149</sup> The Columbia Basin Fish & Wildlife News Bulletin Posted March 12, 2010 on <http://www.cbbulletin.com/379763.aspx>

**Table 27. EPA Region 10 State Fish Consumption Rates Related to Water Quality Standards**

Fish Consumption Rate	State	Status of WQS
6.5	Alaska	Promulgated by EPA carcinogens
6.5		Promulgated by EPA noncarcinogens
6.5	Idaho	Adopted by Idaho & approved by EPA
17.5		Adopted and submitted by Idaho; no action by EPA
6.5	Oregon	Approved by EPA
17.5		Adopted and submitted by Oregon
Considering 175		Disapproved by EPA June 01, 2010
6.5		Will propose new FCR January 2011
Considering new FCR	Washington	Promulgated by EPA
		Washington will initiate Triennial Review public meetings fall 2010 (FCR likely to be raised).

## Summary and conclusions

As shown in this chapter, a large range of fish consumption rates have been used in a regulatory context both for establishing cleanup standards and for developing tribal water quality standards.

This chapter provided a survey of fish consumption rates used in the Washington, including mention of EPA Region 10 framework for decisions at federal cleanup sites and DOH health considerations.

Washington's MTCA Cleanup Regulation, Sediment Management Standards, and Water Quality Standards for Surface Waters all use fish consumption rates as a parameter for developing standards protective of human health.

Cleanup standards developed under the MTCA Cleanup Regulation and Sediment Management Standards are based on exposure estimates defined as a "reasonable maximum exposure." The RME is based on the most beneficial unrestricted use of surface waters, which assumes for an adult, a fish consumption rate of 54 g/day.

Washington's numeric water quality standards for the protection of human health are established based on a 6.5 g/day fish consumption rate from the National Toxics Rule.

Ecology believes that this lack of consistency creates uncertainty and contributes to regulatory delay. The remainder of this report focuses on a proposal for:

- A methodology for evaluating or setting site-specific fish consumption rates (Chapter 6).
- A default fish consumption rate protective of Washington fish consumers (Chapter 7).

Note to reviewers: this report has been written primarily with cleanup objectives in mind, while acknowledging related regulations. TCP recognizes that there are unresolved issues regarding timing and implementation of updates to the Washington Water Quality Standards. This report has not attempted to address these issues.

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## Chapter 6: Site-Specific Fish Consumption Rates

### Introduction

Cleanup decisions are largely based on preventing health risks associated with the consumption of contaminated fish and shellfish. For site-specific cleanup decisions, default parameters may have to be adjusted to account for specific needs related to the site.

Consistent with EPA guidance and policy and precedence established by Ecology for the cleanup of contaminated sites (Port Angeles-ITT Rayonier), the fish and shellfish habitat quality and abundance must be evaluated and considered when establishing a site-specific fish consumption rate for cleanup purposes.<sup>150,151,152,153</sup> Additional factors, such as how much fish consumed is attributable to the site (the fish diet fraction) and whether to include salmon in a fish consumption rate, may need consideration.<sup>154,155</sup>

Under the MTCA Cleanup Regulation, cleanup levels are based on estimates of the RME.<sup>156</sup>

- The RME is designed to represent a high end (but not worst case) estimate of individual exposures. It provides a conservative estimate that falls within a realistic range of exposures.<sup>157</sup>
- The RME is defined as reasonable because it is a product of several factors that are an appropriate mix of average and upper-bound estimates. RME estimates typically fall between the 90th and 99.9th percentile of the exposure distribution.<sup>158</sup>
- The RME takes into account both current and reasonably foreseeable future conditions.

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<sup>150</sup> U.S. Environmental Protection Agency, Region 10. EPA Region 10 Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia, August 2007.

<sup>151</sup> U.S. Environmental Protection Agency. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. EPA-822-B-00-005. October 2000 [<http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/health/methodology/index.cfm>]

<sup>152</sup> Washington State Department of Ecology. Site-Specific Proposal for Modifying the Default MTCA Fish Consumption Exposure Parameters. Questions and Background Information. Prepared for the MTCA Science Advisory Board. March 2008 [[http://www.ecy.wa.gov/programs/tcp/SAB/SAB\\_mtg\\_info/mtg\\_info.htm](http://www.ecy.wa.gov/programs/tcp/SAB/SAB_mtg_info/mtg_info.htm)]

<sup>153</sup> Washington State Department of Ecology. Continuation of Site-Specific Proposal for Modifying the Default MTCA Fish Consumption Exposure Parameters. Factors to Consider for Inclusion/Exclusion of Salmon for Tribal Fish Consumption. Prepared for the MTCA Science Advisory Board. June 02, 2008 [[http://www.ecy.wa.gov/programs/tcp/SAB/SAB\\_mtg\\_info/mtg\\_info.htm](http://www.ecy.wa.gov/programs/tcp/SAB/SAB_mtg_info/mtg_info.htm)]

<sup>154</sup> Washington State Department of Ecology. Site-Specific Proposal for Modifying the Default MTCA Fish Consumption Exposure Parameters. Questions and Background Information. Prepared for the MTCA Science Advisory Board. March 2008 [[http://www.ecy.wa.gov/programs/tcp/SAB/SAB\\_mtg\\_info/mtg\\_info.htm](http://www.ecy.wa.gov/programs/tcp/SAB/SAB_mtg_info/mtg_info.htm)]

<sup>155</sup> Washington State Department of Ecology. Continuation of Site-Specific Proposal for Modifying the Default MTCA Fish Consumption Exposure Parameters. Factors to Consider for Inclusion/Exclusion of Salmon for Tribal Fish Consumption. Prepared for the MTCA Science Advisory Board. June 02, 2008 [[http://www.ecy.wa.gov/programs/tcp/SAB/SAB\\_mtg\\_info/mtg\\_info.htm](http://www.ecy.wa.gov/programs/tcp/SAB/SAB_mtg_info/mtg_info.htm)]

<sup>156</sup> MTCA defines the RME as the "...the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and potential future site use." CERCLA provides a similar definition "...the highest exposure that is reasonably expected to occur at a Superfund site..."

<sup>157</sup> U.S. Environmental Protection Agency. An Examination of EPA Risk Assessment Principles and Practices. EPA/100/B-04/0001. March 2004.

<sup>158</sup> IBID.



Under MTCA, the default fish consumption rate and fish diet fraction are based on a recreational angler exposure scenario. However, the rule provides the flexibility to establish more stringent cleanup levels when Ecology determines that such levels are “...necessary to protect other beneficial uses or otherwise protect human health and the environment...” (WAC 173-340-730(1)(e)).

This chapter identifies elements to consider in deriving a site-specific fish consumption rate protective of human health. It is organized around three questions:

- When is it appropriate to use a site-specific fish consumption rate?
- What factors must be considered in deriving site-specific fish consumption rate?
- What additional exposure parameters (i.e., fish diet fraction, exposure duration, body weight) should be considered when deriving a site-specific fish consumption rate?

## When to use a site-specific fish consumption rate

A site-specific fish consumption rate may be needed when default exposure parameters do not adequately protect the fish-consuming population in question. This allows for consideration of exposure parameters tailored to a specific fish-consuming population within a particular watershed or water body. The goal is for regulatory decisions to be health protective and based on up-to-date information on contamination, exposure, fish dietary and habitats and patterns.

The EPA’s Ambient Water Quality Criteria Methodology provides a useful hierarchy of fish consumption data for use in developing a site-specific fish consumption rate.<sup>159</sup> In order of preference:

- Consumption surveys representative of the population and watershed being addressed at the site
- Consumption surveys representative of similar populations and watersheds to those being evaluated
- National consumption data
- MTCA default values

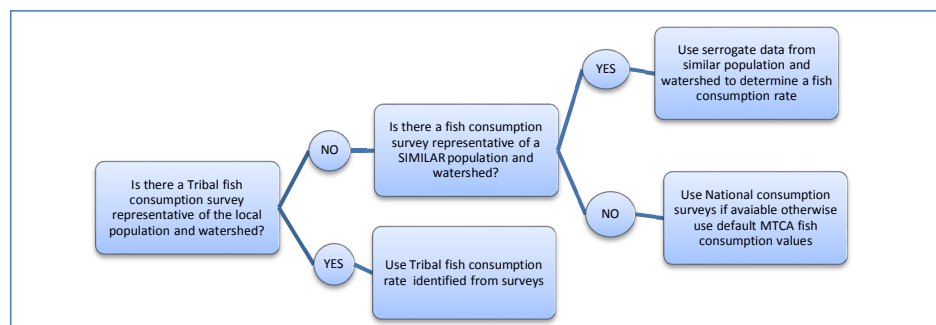
Ecology further believes that surveys used should adhere to the standards identified in previous chapters of this report. Using this hierarchy of fish consumption information in conjunction with an assessment of fish/shellfish habitat quality and quantity, the EPA Region 10 Framework provides a method to determine a fish consumption rate in the absence of a fish/shellfish dietary survey for specific fish-consuming populations.<sup>160</sup>

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<sup>159</sup> U.S. Environmental Protection Agency, Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000), EPA-822-B-00-004.

<sup>160</sup> EPA Region 10 Framework, 2007. Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia, August 2007.

The EPA Region 10 Framework uses two well conducted fish/shellfish dietary surveys conducted in the Puget Sound area as surrogates for other fish-consuming populations based on consideration of fish/shellfish habitat quality and quantity. Using tribal fish consumption as an example of a fish-consuming population, Figure 2 below provides a brief over view of the decision logic of the Region 10 Framework.



**Figure 2. Decision Logic Overview**

Ecology recognizes that in developing a site-specific rate it is important to consider the unique characteristics of the fish-consuming population. For example, for a site-specific fish consumption rate evaluation to support the cleanup of Port Angeles harbor area, exposure factors were evaluated for a fish-consuming population for the Port Angeles area, the Lower Elwha Klallam Tribe (LEKT). For the LEKT, the MTCA Science Advisory Board between March 2007 and June 2008 considered modifying different fish consumption-related MTCA exposure factors.<sup>161</sup>

## Factors to consider

A variety of elements related to fish/shellfish habitat quality and abundance are important considerations to support fish/shellfish harvests for fish-consuming populations in Washington.

### Environmental considerations

Healthy fish and shellfish habitats are critical to support and sustain harvests relied on by Washington fish-consuming populations. Various environmental factors to consider when deriving a site-specific fish/shellfish consumption rate include the following<sup>162,163,164,165</sup>:

<sup>161</sup> MTCA Science Advisory Board Meeting Information found at web location: [http://www.ecy.wa.gov/programs/tcp/SAB/SAB\\_hp.html](http://www.ecy.wa.gov/programs/tcp/SAB/SAB_hp.html)

<sup>162</sup> Marine Life of the Pacific Northwest: A Photographic Encyclopedia of Invertebrates, Seaweeds and Selected Fishes. By Andy Lamb and Bernard Hanby Harbour Publishing. ISBN 1-55017-361-8. Copyright © 2005

<sup>163</sup> The Intertidal Bivalves of British Columbia by D.B. Quayle. British Columbia Provincial Museum Handbook No. 17, ISBN 0-7718-8087-1, Victoria, Canada. 1960.

<sup>164</sup> Marine Invertebrates of the Pacific Northwest by Eugene N. Kozloff with Collaboration of Linda H. Price. University of Washington Press. ISBN 0-295-97562-8. Copyright ©1987, 1996, Second printing, 1999.

<sup>165</sup> The Behavior and Ecology of Pacific Salmon & Trout By Thomas P. Quinn. University of Washington Press. ISBN 0-295-98457-0. 2005

- Historical information on habitat quality, abundance, and density estimates that can provide a baseline for site-specific evaluations
- Population growth and urban impacts on fish/shellfish habitat and abundance (habitat alterations)
- Toxic contamination of habitat and resultant fish tissue concentrations
- The extent and quality of habitat for supporting fish and shellfish harvests in and adjacent to areas of the site – including:
  - Inter-tidal habitat characteristics needed by finfish
  - Intertidal vegetation (eel grass) that provides feeding and forage opportunities
  - Identification of the nature and extent of contamination
- Inter-tidal habitat characteristics required for shellfish beds (i.e., sand, light to heavy gravel, sedimentation influences, wood waste (if applicable))
- Inter tidal and river water temperature variation and oxygen levels
- Tidal influences
- River flow rates
- Fish species and life history
- Residency times for fish/shellfish populations in estuary or inter-tidal zones
- Any relevant closures, warnings, or conditional closures or advisories

### **Available resources and habitat**

The Watershed Planning Act (WPA; RCW 90-82), passed by the Washington State Legislature in 1998, provides for locally-based watershed planning and management for different watersheds throughout Washington. A watershed is an area draining into a river, lake or other waterbody, such as the Puget Sound. The watershed management plan is developed in collaboration with citizens, local governments, and tribal governments to develop solutions to water issues in their own watershed. Chapter 173-500 WAC established the Water Resource Inventory Areas planning units.<sup>166</sup> Final decisions regarding the watershed management plan for the planning units must be made by the unanimous consensus of the initiating governments (county, city, and tribal) and the Department of Ecology.<sup>167</sup>

Working in collaboration with other natural resource agencies, the Department of Ecology has divided Washington into 62 Water Resource Inventory Areas to delineate the state's major watersheds.<sup>168</sup> Depending on the WRIA of interest information, accessing the watershed planning and management information may provide a range of information on water quantity and quality, fish and shellfish habitat quality and abundance, in-stream flow patterns, intertidal

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<sup>166</sup> RCW 90.82.040.

<sup>167</sup> Chapter 90.82 RCW, Watershed Planning, RCW Sections 90.82.005 to 90.82.902

<sup>168</sup> Watershed Updates by Water Resource Inventory Areas (WRIA) at web site: <http://www.ecy.wa.gov/apps/watersheds/wriapages/index.html>

habitat, and corrective management plans. An example of this type of information available is the Water Resource Inventory Area 20, Watershed Management Plan.<sup>169</sup>

## Shellfish growing areas

The National Shellfish Sanitation Program provides the regulatory framework for coastal states to identify, survey and classify shellfish growing waters. The classification status of shellfish is based on sanitary surveys of water quality and shoreline surveys of pollution sources.

Shellfish growing areas are classified either as approved for harvest or as one of four harvest limited categories: 1. conditionally approved, 2. restricted, 3. conditionally restricted, 4. prohibited

All identified shellfish growing and harvest areas must be classified as prohibited unless sanitary surveys indicate that water quality meets regulatory standard for the other categories.<sup>170</sup>

For 1995, Washington had 308,000 classified shellfish acreage with 36 percent harvest limited.<sup>171</sup> In 2009 the Washington Department of Health managed the classification of 356,253 commercial shellfish harvesting acres.<sup>172</sup> In 2009, for Washington, there were 287,741 acres with approved classifications, 6,208 acres with conditionally approved classifications, 981 acres with restricted classifications, and 61,323 acres with prohibited classifications.

## Suppression effects

Current Native American fish consumption is lower than historical fish consumption and fewer Native Americans practice subsistence fishing.<sup>173,174,175</sup> Possible reasons for suppressed fish consumption rates are:<sup>176,177</sup>

- Habitat degradation
- Treaty-reserved fish rights remain unrecognized by local and state jurisdictions
- Reduced or inaccessible areas to harvest fish due to increased urbanization or contamination
- Fewer numbers of Native American are practicing subsistence or traditional lifestyles

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<sup>169</sup> Water Resource Inventory Area 20, WRIA 20 Planning Unit, Watershed Management Plan. June 2009. Web location: <http://www.ecy.wa.gov/services/gis/maps/wria/number/wria20.htm>

<sup>170</sup> National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). "Classified Shellfish Growing Waters" by C.E. Alexander. NOAA's State of the Coast Report. Silver Spring, MD: NOAA. [URL: http://state\\_of\\_coast.noaa.gov/bulletins/html/sqw\\_04/sqw.html](http://state_of_coast.noaa.gov/bulletins/html/sqw_04/sqw.html)

<sup>171</sup> IBID, Table 1.

<sup>172</sup> Washington State Department of Health. 2009 Annual Report: Commercial and Recreational Shellfish Areas in Washington State. Office of Shellfish and Water Protection. July 2010. Office web site: [www.doh.wa.gov/ehp/sf](http://www.doh.wa.gov/ehp/sf)

<sup>173</sup> Subsistence Native American fish consumers are a subset of the Native American tribal population (Donatuto and Harper, 2008).

<sup>174</sup> Harper and Harris, 2008. Barbara L. Harper and Stuart G. Harris. A Possible Approach for Setting A Mercury Risk-Based Action Level Based on Tribal Fish Ingestion Rates. Environmental Research 107 (2008), 60-68.

<sup>175</sup> Donatuto and Harper, 2008. Jamie Donatuto and Barbara L. Harper. Issues in Evaluating Fish Consumption Rates for Native American Tribes. Risk Analysis, Vol. 28, No. 6, 2008. Pages 1497-1506.

<sup>176</sup> Harper and Harris, 2008. Barbara L. Harper and Stuart G. Harris. A Possible Approach for Setting A Mercury Risk-Based Action Level Based on Tribal Fish Ingestion Rates. Environmental Research 107 (2008), 60-68.

<sup>177</sup> Fish Consumption and Environmental Justice. A Report developed from the National Environmental Justice Advisory Council Meeting of December 3-6, 2001. November 2002 (revised).

- Reduced numbers of fish/shellfish populations available to harvest
- Knowledge of fish/shellfish contamination may reduce harvests and consumption
- Methodological issues and data interpretation related Native American dietary surveys that may not fully account for their high fish consumption habits and patterns

Suppression effects are of particular concern for subsistence fishers consuming fish or shellfish at rates greater than high fish consumers.<sup>178</sup> Although acknowledging variation across different Pacific Northwest tribal populations, researchers have suggested a tribal fish consumption rate above 454 grams/day for subsistence fishers, and 540 grams/day has been established as a subsistence fish consumption rate for the Umatilla Tribe.<sup>179,180</sup>

## Exposure parameters

On a site-specific basis, it may be necessary to adjust default exposure assumptions in order to establish sediment or surface water cleanup standard based on a reasonable maximum exposure to the fish-consuming population impacted by the site. (The exposure assumption and equations for establishing water quality standards vary slightly and are not addressed in this report; interested readers are referred to EPA guidance.)

In addition to a fish consumption rate, body weight, fish diet fraction, and exposure duration parameters are used to set surface water and sediment cleanup standards protective of human health.

### Body weight

Based on exposure assumptions of the MTCA Cleanup Regulation RME, surface water cleanup standards protective of human health are computed based on a default adult male body weight of 70 kilograms (kg). Body weight, along with an estimate of fish consumption, duration, and frequency of exposure is used to derive media specific protective risk-based concentrations.

Regarding differences between children and adult body weights, Oregon's Human Health Focus Group noted the following:

"In the case of adult males (18 to 74 years of age), mean body weight is 78 kg (172 lbs), with the 5th and 95th percentile weights of 59 kg (130 lbs) to 103 kg (227 lbs), respectively. Mean adult

<sup>178</sup> Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Principal Investigator: Barbara L. Harper. Co-investigators: Anna K. Harding, Therese Waterhouse, and Stuart G. Harris. U.S. EPA Grant Number EPA-STAR-J1-R831046. August 2007

<sup>179</sup> Harper and Harris, 2008. Barbara L. Harper and Stuart G. Harris. A Possible Approach for Setting A Mercury Risk-Based Action Level Based on Tribal Fish Ingestion Rates. Environmental Research 107 (2008), 60-68.

<sup>180</sup> Harris, S.G., Harper, B.L., 1997. A Native American Exposure Scenario. Risk Analysis 17, 789-795.

female body weight for the same age range is 65 kg (143 lbs), with 5th and 95th percentiles of 48 kg (106 lbs) and 93 kg (205 lbs), respectively.<sup>181</sup>

The variation of weight between children and adults is significant, considering that newborns typically weigh 4 kg (8 lbs) while adults can reach weights of 113 kg (250 lbs). Thus, risk estimates for children versus adults can vary considerably. In the current water quality criteria guidance EPA recommends using an average adult body weight of 70 kg (154 lbs) as a default body weight value in water quality criteria calculations. While use of water quality criteria based on the adult default weight provides adequate protection for adults, it may not provide adequate protection for children.<sup>182</sup>

Similar to the body weight variation between adults and children in computing ambient water quality criterion, surface water cleanup standards are based on an adult male body weight. EPA directs tribes and state agencies to use alternative body weight estimates for populations other than the general populations when these estimates are more protective for the populations of concern. For example, EPA recommends using a default body weight of 30 kg (66 lbs) to be protective of children when exposure to environmental contaminants may have early-life effects. Recognizing the hierarchy of information used to establish site-specific water quality standards, EPA directs states and tribes to use local or regional data when available to compute health protective water quality criteria.<sup>183</sup>

## Fish diet fraction

The fish diet fraction (FDF) is defined as “...the percentage of the total fish and/or shellfish in an individual’s diet that is obtained or has the potential to be obtained from the site.”<sup>184185</sup> (The MTCA rule establishes a default fish diet fraction (50 percent). However, the rule provides the flexibility to modify the fish diet fraction when necessary to establish a more stringent cleanup level to protect human health.”<sup>186</sup> Ecology believes that the following factors should be considered when selecting a fish diet fraction on a site-specific basis in consideration of a fish/shellfish-consuming population:

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<sup>181</sup> Oregon Department of Environmental Quality, Water Quality Division – Standards and Assessments. Human Health Focus Group Report, Oregon Fish and Shellfish Consumption Rate Project. June 2008. Page 36 noted the reference for body weights as USEPA 1997. Exposure Factors Handbook Revised. Chapter 7 Body Weight Studies Retrieved May 27, 2008, from <http://www.epa.gov/ncea/efh/>.

<sup>182</sup> Oregon Department of Environmental Quality, Water Quality Division – Standards and Assessments. Human Health Focus Group Report, Oregon Fish and Shellfish Consumption Rate Project. June 2008. Page 36 noted the reference for body weights as USEPA 1997. Exposure Factors Handbook Revised. Chapter 7 Body Weight Studies Retrieved May 27, 2008, from <http://www.epa.gov/ncea/efh/>

<sup>183</sup> IBID.

<sup>184</sup> WAC 173-340-200

<sup>185</sup> Site is defined in WAC 173-340-200 to mean the same as “facility,” which is defined to mean the following (emphasis added):

“Any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, vessel, or aircraft; or any site or area where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located.”

<sup>186</sup> WAC 173-340-708(10)(b)

- The range of fish-diet fraction values used to make site-specific decisions. The EPA Region 10 Framework recommends the use of a relative source contribution equal to 100 percent.<sup>187</sup> Ecology and EPA have used this value when evaluating health risks for tribes at several cleanup sites in Washington (e.g., Bellingham Bay and the Lower Duwamish Waterway). Ecology has also used or is considering using a fish diet fraction less than 50 percent in other areas.
- Practical risk management decisions. From a practical standpoint, risk-based concentrations for sediments or surface waters calculated using higher fish consumption rates will, for many contaminants, fall below background concentrations. In these situations, cleanup standards will likely be based on considerations other than fish consumption or fish diet fraction.
- Estimates of the reasonable maximum exposure.<sup>188</sup> The RME is designed to represent a high end (but not worst case) estimate of individual exposures. It provides a conservative estimate that falls within a realistic range of exposures.<sup>189</sup> The RME is defined as reasonable because it is a product of several factors that are an appropriate mix of average and upper-bound estimates. RME estimates typically fall between the 90th and 99.9 percentile of the exposure distribution.<sup>190</sup>
- Current fish and shellfish harvesting and consumption habits and patterns. In the absence of a well designed and conducted fish dietary survey Ecology recommends the EPA Region 10 Framework on a site-specific basis. However, modifications to the default fish diet fraction need to consider whether using a surrogate fish/shellfish rate would lead to exposure estimates above the 95<sup>th</sup> percentile value generally used by Ecology when establishing cleanup levels and standards.
- Reasonably anticipated future fish and shellfish harvesting and consumption habits and patterns, including reasonably anticipated future habitat conditions.

## Exposure duration

Groundwater and surface water cleanup standards for carcinogens are based on an exposure duration of 30 years.<sup>191</sup> This 30 year exposure duration was based on the estimated household residency time for U.S. populations.<sup>192</sup> It is consistent with EPA Mid-Atlantic Risk Assessment

<sup>187</sup> EPA Region 10 Framework (2007) states "Although the degree to which site-related risks could be overestimated by the use of any of the fish and shellfish consumption rates presented in this Framework cannot be known precisely, these methods are preferable to alternatives that would be likely to underestimate site-related risks, such as basing a consumption rate (or site-related estimates of risk) on the size of the cleanup site, or reducing the site's estimated contribution to fish and shellfish contamination because nearby sites or sources are associated with similar contaminants." This Framework includes the assumption that the selected Tribal fish and shellfish consumption rates and their associated risk estimates will not be reduced based on consideration of the size of the cleanup site or the presence of additional sources of contamination. (Page 23)

<sup>188</sup> MTCA defines the RME as the "...the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and potential future site use." CERCLA provides a similar definition "...the highest exposure that is reasonably expected to occur at a Superfund site..."

<sup>189</sup> U.S. Environmental Protection Agency. An Examination of EPA Risk Assessment Principles and Practices. EPA/100/B-04/0001. March 2004.

<sup>190</sup> IBID.

<sup>191</sup> WAC 173-340-200

<sup>192</sup> U.S. Environmental Protection Agency. Exposure Factors Handbook: 2009 Update. EPA/600/R-09/052A, July 2009.

Equations in their fish ingestion and tap water equations for carcinogens.<sup>193</sup> The U.S. EPA 2009 Exposure Factors Handbook provides descriptive statistics for residency times.<sup>194</sup>

- Mean is 13 years
- 90<sup>th</sup> percentile is 32 years
- 95<sup>th</sup> percentile is 46 years
- 99<sup>th</sup> percentile is 62 years.

The 30 year exposure duration specified in the MTCA rule approximates the 90<sup>th</sup> percentile residence time in the same household (in other words, 90 percent of the U.S. population reside in the same household for 30 years or less). On a site-specific basis, the exposure duration may vary depending on the population's mobility. Factors to consider when changing the exposure duration are:

- *Demographic and population-specific census information* related to residency times and potential period of exposure to a hazardous substance. For example, some tribal populations may live on or near their reservation for periods longer than 30 years. Tribal elders may reside on or near reservations for a significant portion of their lives, 50 years or longer.<sup>195</sup>
- *Consistency with EPA Regional and federal guidance and policies* for site-specific evaluations. The EPA Region 10 Framework and the EPA methodology for deriving surface water cleanup standards and criteria protective of human health established an information hierarchy of preferred exposure data. The highest preference is given to exposure information (fish dietary information) from local watersheds representative of the people being addressed for the particular water body.<sup>196,197,198,199</sup>
- *Consistency with Exposure Assumptions Used At Other Cleanup Sites* that evaluate population-specific exposures from contaminants. For example, exposure duration was considered for site-specific evaluations and cleanup decisions at the ITT Rayonier Port Angeles site and the Lower Duwamish Waterway.<sup>200,201</sup>

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<sup>193</sup> Mid-Atlantic Risk Assessment. Regional Screening Table. Web Location: [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)

<sup>194</sup> U.S. Environmental Protection Agency. Exposure Factors Handbook: 2009 Update. EPA/600/R-09/052A, July 2009. Information from Table 16-5, page 16-9.

<sup>195</sup> Lower Elwha Klallam Tribe Fish Consumption and the EPA Region 10 Framework. Frances Charles, Lower Elwha Tribal Chairperson and Larry Dunn, LEKT, Rayonier Project Coordinator. Submitted to the Dept. of Ecology in consideration of site-specific cleanup for Port Angeles harbor area. October 15, 2007.

<sup>196</sup> U.S. Environmental Protection Agency. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000). EPA-822-B-00-004. October 2000.

<sup>197</sup> U.S. Environmental Protection Agency. Estimated Per Capita Fish Consumption in the United States. EPA-821-C-02-003. August 2002. [http://www.epa.gov/waterscience/fish/consumption\\_report.pdf](http://www.epa.gov/waterscience/fish/consumption_report.pdf)

<sup>198</sup> U.S. Environmental Protection Agency, Region – 10. Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia. Office of Environmental Assessment. August 2007

<sup>199</sup> U.S. Environmental Protection Agency. Fish Consumption and Environmental Justice. National Environmental Justice Advisory Council. November 2002. [http://www.epa.gov/compliance/resources/publications/ej/fish\\_consump\\_report\\_1102.pdf](http://www.epa.gov/compliance/resources/publications/ej/fish_consump_report_1102.pdf)

<sup>200</sup> Washington State Department of Ecology. Port Angeles Harbor-Marine Environment. Baseline Human Health and Ecological Risk Assessment. PUBLIC REVIEW DRAFT. March 2011.



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<sup>201</sup> Lower Duwamish Waterway Group. Lower Duwamish Waterway Remedial Investigation. Appendix B: Baseline Human Health Risk Assessment. Final. November 2007

## Chapter 7: Recommendations

### Introduction

Ecology is considering revisions to the Sediment Management Standards rule (WAC 173-204) and, over the next several years, will consider updates to the Water Quality Standards for Surface Waters (WAC 173-201A), and the Model Toxics Control Act (MTCA) Cleanup Regulation (173-340).

This chapter reviews issues and options related to fish consumption rates. It provides the rationale behind the recommendation that the default rate or rates be within an identified range.

The question being addressed is identifying a technically defensible range for a default fish consumption rate (or rates) for use in regulatory decisions. The initial focus is cleanup decisions, and revisions to the SMS will address establishing cleanup levels protective of high fish consumers while maintaining the flexibility for site specific decisions.

This approach takes into account current scientific information, regional differences, variability, and uncertainty. Ecology views this preliminary recommendation as a starting point for discussions.

Subsequent rule revision proposals will be evaluated according to regulatory analyses required under the Washington Administrative Procedures Act and the State Environmental Protection Act.

This chapter is organized into four sections:

- *Regulatory Question.* This section states the regulatory question that Ecology is evaluating in this report. The question is framed in manner that identifies the range of scientific and policy factors that Ecology believes are relevant to answering this question.
- *Preliminary Recommendations.* This section provides Ecology's preliminary recommendations on a statewide default fish consumption rate and the rationale for those recommendations.
- *Key Issues.* This section discusses several broad issues that Ecology considered when developing the preliminary recommendations. These include variability in consumption rates, suppression effects, salmon, and child exposures.
- *Summary and Conclusions.* This section summarizes key information in earlier sections and the conclusions based on that information.

### Statement of the regulatory question

Over the last 20 years, numerous scientific and regulatory developments have been made regarding statewide default fish consumption rates. Ecology will be evaluating these

developments to help determine where to establish an appropriate default fish consumption rate (or rates).

The question being considered is:

What is a technically defensible range for developing a default fish consumption rate (or rates) appropriate for use in regulatory decision making?

Key considerations are:

- Recent scientific data on fish and shellfish consumption rates for different population groups.
- Approaches used by other state and federal agencies.
- Uncertainty and variability in fish and shellfish consumption rates for different population groups and individuals within those groups.
- Current and potential future exposures resulting from fish and shellfish consumption.
- State laws and policies, including MTCA and the Water Pollution Control Act.
- Treaty-reserved fishing rights.

## Preliminary recommendations

A default fish consumption rate for use in cleanup decisions should protect high fish consumers of Washington. That is, a default rate should be set so that cleanup decisions protect consumers who eat fish and shellfish at the 90<sup>th</sup> to 95<sup>th</sup> percentile consumption rate. Based on the evaluations in this report, Ecology is preliminarily recommending a default fish consumption rate (or rates) in the range of XXX to YYY grams per day. This is a technically defensible range consistent with risk-management policies in the MTCA Cleanup Regulation and federal regulatory policies and procedures.

**Commented [MH3]:** Work in progress depending on evaluation in Ch 7.

A default fish consumption rate in this range should be used to establish sediment cleanup standards under the SMS rule. In addition, future rulemaking would apply a default rate in this range to surface water cleanup standards under the MTCA rule and water quality standards for surface waters.

## Reasons for the proposed preliminary recommendation

The Washington general population consumes fish and shellfish at rates above current regulatory defaults.

MTCA surface water cleanup standards are currently based on a recreational angler exposure scenario that assumes a fish consumption rate of 54 g/day. Based on the data review, this scenario does not represent the RME at most cleanup sites due to population groups who consume larger amounts of fish and shellfish. These groups include Native Americans, Asian and Pacific Islanders, and subsistence fishers.

Sediment cleanup standards are set on a site-by-site basis using site-specific fish consumption rates, a process that can contribute to cleanup delay.

Washington water quality standards are based on an outdated fish consumption rate of 6.5 g/d, leading many tribes to establish their own, more protective water quality standards.

## **Rationale and basis for the proposed preliminary recommendation**

Ecology developed this preliminary proposal for revising the default fish consumption rate by considering the following questions:

- (1) What exposure scenarios should be considered when establishing a statewide default fish consumption rate?
- (2) What is an appropriate statewide default fish consumption rate given current exposure scenarios?
- (3) What other exposure parameters should Ecology be using in combination with the draft statewide default fish consumption rate?
- (4) What factors should Ecology consider when reviewing the proposed statewide default fish consumption rate during future regulatory reviews?

Each question is considered separately below.

*Question #1:* What exposure scenarios should be considered when establishing a statewide default fish consumption rate?

The statewide default fish consumption rate should take into account the quantity and types of fish and shellfish available in Washington, and consumption habits and patterns of Native Americans, Asian and Pacific Islanders, recreational fishers, and the general population. The rationale for this approach includes both science and policy considerations:

- Defensible dietary information is available from national and Pacific Northwest fish consumption surveys.
- The fish consumption survey information indicates that the proposed default rate would be protective fish consumers.
- The approach is consistent with current Ecology risk-based policy decisions.
- Washington has plentiful commercial and recreational fisheries, and significant numbers of high fish consumers, including Native Americans and Asian and Pacific Islanders.
- Native Americans harvest fish and shellfish from waters throughout the state.

*Question #2:* What is an appropriate statewide default fish consumption rate given current exposure scenarios?

The proposed default fish consumption rate is based on a number of factors.

- It considers current scientific information on fish consumption rates for different population groups in the Pacific Northwest. Ecology has reviewed available fish consumption surveys

relevant to the Pacific Northwest (See Chapter 4). Ecology concluded that information from five surveys provide a solid technical basis for regulatory decisions.

- The Oregon DEQ Human Health Focus Group reached similar conclusions. Ecology's focus on these five studies is also consistent with EPA's hierarchy of information and preferences for local data. The results and findings from these five studies are consistent with scientific information on fish consumption rates from other parts of the United States.
- The preliminary recommendation is consistent with Ecology's policy decision to base cleanup standards on a "reasonable maximum exposure" and with current MTCA policies. The default considers several exposure scenarios, including the general population and population groups known to consume higher amounts of fish and shellfish. It takes into account the variability in fish consumption rates among population groups and individuals. Specifically, the preliminary recommendation falls in between the 90th and 95th percentile for 5 of the 6 study populations considered in this evaluation.
- The preliminary recommendation falls with the range of fish consumption rates identified in EPA Superfund policies and guidance.<sup>202</sup>
- The preliminary recommendation is consistent with recommendations in 1997 EPA *Exposure Factor Handbook*, where EPA recommends an average ingestion rate of 70 g/day and a 95<sup>th</sup> percentile ingestion rate of 170 g/day.<sup>203</sup>
- The preliminary recommendation was developed using methods and policies similar to those used by the Oregon Department of Environmental Quality (ODEQ) in proposing revisions to the Oregon water quality standards. ODEQ is proposing to use a default fish consumption rate of 175 g/day.<sup>204</sup> In support of the effort to revise the Oregon water quality standards, ODEQ organized the Human Health Focus Group to evaluate fish consumption information and recommend a fish consumption rate for fish-consuming populations in Oregon.<sup>205</sup> The Human Health Focus Group concluded that (1) there are relevant studies available for recommending fish consumption rates, (2) Pacific salmon should be included in the fish consumption rate, and (3) fish-consuming populations who eat more than 17.5 g/day of fish and shellfish are at an increased risk of cancer and noncancer adverse health effects.<sup>206</sup>
- The preliminary recommendation falls within the range of fish consumption rates in federally approved water quality standards established by Washington tribes. Several Washington tribes have developed tribal surface water standards based on Native American fish consumption rates. Fish consumption rates in federally approved standards range from 6.5 grams/day to 389 grams/day.
- EPA and Ecology have established cleanup standards at several sites based on tribal fish consumption scenarios. Ecology and EPA currently establish site-specific sediment cleanup

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<sup>202</sup> EPA Region 10 Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia, August 2007. Page 6.

<sup>203</sup> U.S. Environmental Protection Agency. 1997. Exposure Factors Handbook. National Center for Environmental Assessment. Office of Research and Development. August 1997. Available at: <http://www.epa.gov/ncea/efh/>.

<sup>204</sup> Fish consumption rate of 175 grams/day represents the approximate 95<sup>th</sup> percentile from the Columbia River Inter-Tribal Fish Consumption Survey noted as a critical study by the Oregon Human Health Focus Group.

<sup>205</sup> The Oregon Human Health Focus Group consisted of regional experts with experience in areas of toxicology, risk assessment, public health, biostatistics, and/or epidemiology.

<sup>206</sup> Human Health Focus Group Report, Oregon Fish and Shellfish Consumption Rate Project, June 2008.

standards and/or screening levels based on tribal fish consumption rates in areas designated as usual and accustomed fishing areas for one or more tribes.<sup>207</sup> In general, fish consumption rates used at these sites range from around 50 to 300 g/day (Malcolm Pirnie, 2008).<sup>208</sup>

*Question #3:* What other exposure parameters should Ecology be using in combination with a statewide default fish consumption rate?

Fish consumption is a major exposure pathway considered when establishing cleanup standards. As discussed in Chapter 5, the fish consumption rate is one of several exposure parameters used to establish risk-based standards based on this exposure pathway. The regulatory choices for other parameters can significantly impact the resulting standards.

Other key exposure parameters include:

- Body weight.
- Exposure duration.
- Fish diet fraction.

Although these are relevant parameters, at this time Ecology has not considered them in establishing a default fish consumption rate. They are appropriately considered when establishing site-specific fish consumption rates, as described in Chapter 6.

*Question # 4:* What factors should Ecology consider when reviewing the proposed statewide default fish consumption rate during future regulatory reviews?

Ecology considered a variety of factors that affect fish-consuming populations and the fish consumption rate for Washington fish consumers. Future regulatory reviews and/or rulemaking regarding fish consumption and the fish-consuming habits and patterns of fish consumers will consider, at a minimum:

- Technical quality of information.
- Environmental justice related issues.
- Federal and state regulatory policies and procedures.
- Federal directives, such as presidential executive orders.
- Native American customs and practices.
- Other considerations to be determined.

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<sup>207</sup> Technical Memorandum. Human Health Risk Evaluation of Mercury in Sinclair Inlet Seafood, OU B Marine. Bremerton Naval Complex. Department of the Navy, Naval Facilities Engineering Command Northwest. Final 12 August 2010.

<sup>208</sup> Malcolm Pirnie. 2008. Scientific Considerations for Identifying Subsistence User Ingestion Rates in Port Angeles, Washington. Figure 1 summarizes fish consumption rates used at nine cleanup sites. One value (KPC) appears to be 6.5 g/day.

## Policy issues associated with developing a default fish consumption rate

A number of policy issues were considered in developing a preliminary default fish consumption rate recommendation. Ecology considered the reasonable maximum exposure; how to account for consumption of Pacific salmon caught in Washington waters; and uncertainty regarding the estimates for consumption.

Studies indicate that tribal fish consumption rates are suppressed compared with historical rates and presumable rates that would exist given historical fishing stocks. However, the default fish consumption rates proposed by this report was developed using existing data from published studies. The issue of suppression may important when setting site-specific cleanup standards that consider historical site characteristics.

### The question of whether to include salmon

Ecology has reviewed information related to salmon stocks and salmon available for harvests throughout Washington. The available Pacific Northwest consumption surveys, with a focus on the Puget Sound fish consumption, documents salmon as one of many fish species consumed by Washington fish consumers. Ecology believes that salmon should be included in the Washington default fish consumption because:

- There are sufficient numbers of salmon harvested throughout Washington.
- Salmonids are harvested for recreational and commercial purposes by state fish-consuming populations.<sup>209</sup>
- Salmonids may contribute to the contaminant body burden of fish-consuming populations.
- Salmonids have historical, cultural, and religious significance for Washington Native Americans.

### Choice of the reasonable maximum exposure

Exposure to hazardous substances is influenced by multiple factors. Thus, wide ranges often exist in exposures within a given population. Agencies may have some information on the range of values for a particular parameter (for example, fish consumption rates). However, agencies must also decide which value within the range to use to characterize the range of values (that is, whether to use either an average or the high end of the range). Choosing a summary measure to characterize population exposure reflects an explicit (or implicit) policy choice on the appropriate balance between over- or underestimating exposure levels for particular individuals within the population group.

Cleanup standards are based on estimates of the “reasonable maximum exposure” or “RME.” The MTCA rule defines the RME as “the highest exposure that is reasonably expected to occur

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<sup>209</sup> Washington Department of Fish and Wildlife. Salmon Recover. Provides information on Hatcheries, Harvests, Salmon Recovery Plans, Salmon Habitat, and a variety of other salmon related information. Web location: <http://wdfw.wa.gov/recovery.htm>

at a site under current and potential future site use.” In general, fish consumption rates corresponding to the RME fall between the 90<sup>th</sup> and 99.9<sup>th</sup> percentile of the exposure distribution.

### **Derivation of the preliminary recommendation**

Ecology used the state surveys identified in Chapter 4 plus the EPA fish consumption rate data for U.S. fish consumers to identify the recommended range for establishing a default fish consumption rate or rates. Although for simplicity’s sake, a single statewide default rate may be preferable, different regulatory goals and regional differences suggest multiple options. One option could be to create geographically defined rates (for example, east and west, or Puget Sound and non-Puget Sound).

Again, the goal is to develop default fish consumption rates appropriate for use in regulatory decision making. Regulations should provide consistency and predictability for the people of the state. So while multiple geographically defined default rates would take into account regional differences, it might also add a level of regulatory complexity. It is uncertain whether this complexity would increase health protection, which depends on a number of factors. Cleanup decisions around bioaccumulative chemicals are increasingly based on background concentrations. In these cases, regional differences in fish consumption rates would not affect cleanup standards. Water quality criteria based on human health provide long-term water-body based goals, and even current values are difficult to achieve. Given the implementation challenges around both of these issues, standards should be science-based and developed using current and technically defensible data. Standards should also be designed to allow flexible implementation strategies.

The median, 90<sup>th</sup> and 95<sup>th</sup> percentiles of the different populations are summarized in Table 28 below. (See also Appendix A, Table A-1.)

There are multiple options for looking at these data.

1. All data. Central tendency estimate between the 90<sup>th</sup> and 95<sup>th</sup> percentile using all five state surveys and including the national estimate of fish consumption.
2. Washington surveys only. Central tendency estimate between the 90<sup>th</sup> and 95<sup>th</sup> percentile using the five Washington surveys only, excluding the national estimates. The While the national estimates are useful and provide context, the data was collected in a way that does not allow direct comparison with the other surveys.
3. State and national data but with geographic divisions. Central tendency estimate between the 90<sup>th</sup> and 95<sup>th</sup> percentile and excluding the Suquamish data. The high shellfish consumption of the Suquamish is associated with productive marine shellfish beds and habitat not found in other parts of the state.
4. State surveys only with geographic divisions. Central tendency estimate between the 90<sup>th</sup> and 95<sup>th</sup> percentile excluding both national data and Suquamish data.



**Table 28. Selected Descriptive Statistics (grams/day) and Resulting FCR Ranges**

Pacific Northwest and U.S. General Fish-Consuming Populations Surveys <sup>210</sup>			
Survey	Median	90th percentile	95th percentile
Tulalip Tribe	45	186	244
Suquamish Tribe	132	489	796 <sup>211</sup>
Squaxin Island Tribe	42	193	247
Columbia River Tribes	40	113	176
Asian & Pacific Islanders	78	236	306
U.S. General Population	99	248	334
RANGE			
Central tendency estimate of the upper percentiles by averaging all 5 state surveys and the national data		244	350
Central tendency estimate of the upper percentiles by averaging state data only		243	253
Central tendency estimate of the upper percentiles, recognizing geographic distinctions in the state data and including national data (averages exclude Suquamish data)		195	261
Central tendency estimate of the upper percentiles, recognizing geographic distinctions and using the state data only (averages exclude Suquamish and national data)		182	243
Identify the range broadly to include all regional data, without averaging upper percentiles		113	489 <sup>212</sup>

**Commented [MH4]:** Is the terminology used in this table correct?

Based on these surveys, and considering the various options, default fish consumption rates should be within a range suggested by this data. Default values should be identified by a central tendency estimate between the 90<sup>th</sup> and 95<sup>th</sup> percentiles of the appropriate data. See Appendix C for a graphical display of the data.

**Commented [MH5]:** Should the graphs in Appendix C be brought into this section?

## Statistical analysis

**Commented [MH6]:** Is this a correct title for this section?

The Wilcoxon confidence interval provides information about the median of a distribution. To evaluate the possible ranges of data for the upper percentiles of fish and shellfish consumption for the different populations, Ecology calculated the median of the 95<sup>th</sup> percentiles and corresponding Wilcoxon signed-rank confidence intervals using the WINTERVAL procedure in Minitab.<sup>213 214 215</sup>

Using the fish consumption rate distribution information for the Tulalip, Suquamish, Squaxin Island, and Columbia River tribes as well as API and U.S. general population, the median 95<sup>th</sup> percentile is 289 grams/day, with an approximate 95 percent confidence interval ranging from 210 to 565 grams/day (achieved level of confidence 94.1 percent). Omitting the Suquamish

<sup>210</sup> Adapted from Table 3, page 28 of the DEQ Water Quality Division. Human Health Focus Group Report Oregon Fish and Shellfish Consumption Rate Project (June 2008).

<sup>211</sup> Region 10 Framework Appendix B-2.

<sup>212</sup> The upper 90<sup>th</sup> percentile fish consumption rate for the Suquamish data is 797 g/day. This data is not included in the Oregon Human Health Focus Group report and for this reason Ecology did not use it in setting the range.

<sup>213</sup> M. Hollander and D.A. Wolfe (1973). Nonparametric Statistical Methods, John Wiley & Sons.

<sup>214</sup> D.B. Johnson and T. Mizoguchi (1978). "Selecting the Kth Element in  $X + Y$  and  $X_1 + X_2 + \dots + X_m$ ," SIAM Journal of Computing 7:147-153.

<sup>215</sup> Minitab Inc. (2007). Minitab Statistical Software v.15. Minitab Inc., State College, PA.

Tribe dataset, the median 95<sup>th</sup> percentile is 255 grams/day, with an approximate 95 percent confidence interval ranging from 176 to 334 grams/day (achieving a confidence level of 94.1 percent).

A similar evaluation was conducted using 90 percent confidence intervals around the median. Using all 95<sup>th</sup> percentile data, the median 95<sup>th</sup> percentile is 289 grams/day, with an approximate 90 percent confidence interval ranging from 212 to 561 grams/day (achieving a confidence level of 90.7 percent). Omitting the Suquamish Tribe dataset, the median 95<sup>th</sup> percentile is 256 grams/day, with an approximate 90 percent confidence interval ranging from 210 to 320 grams/day (achieving a confidence level of 89.4 percent).

#### Central tendency estimate of the 95<sup>th</sup> percentile – median and confidence interval calculated from distributions

Distributions used	Median of 95 <sup>th</sup> percentiles	95% confidence interval	90% confidence interval
All 5 state surveys and the national data	289	210-565	212-561
4 state surveys and the national data (excluding the Suquamish data)	256	176-334	210-320

Due to this uncertainty, professional judgment is required in selecting for cleanup purposes a fish consumption rate protective of high fish-consuming populations. Depending on site specific factors, a fish consumption rate may have to be adjusted to account for high fish-consuming populations or subsistence fishers. The preliminary recommendation in this report identifies an appropriate range for a health protective default fish consumption rate.

### Acceptable risk

MTCA cleanup standards and Washington's ambient water quality criteria are both based on an acceptable cancer risk of 1 in 1 million. Selection of a reasonable maximum exposure summary statistic between the 90<sup>th</sup> and 95<sup>th</sup> percentile is consistent with Ecology's policy choices on target or acceptable risk. A higher percentile (for example, the 99<sup>th</sup> percentile) might be preferable if Ecology was basing regulatory decisions on a higher acceptable risk range (such as 1 in 10,000). However, this analysis has not considered changes to the acceptable cancer risk level.

In most cases, environmental agencies consider risk policies only implicitly. The one exception is the Oregon DEQ guidance document on probabilistic risk assessment (DEQ, 1999). In that document, Oregon DEQ explicitly established a policy that used different statistical metrics (percentiles) for different target risk levels. For example, DEQ states "...[f]or individual carcinogens, a lifetime excess cancer risk for each carcinogen of less than or equal to one per one million at the 90th percentile, and less than or equal to one per one hundred thousand at the 95<sup>th</sup> percentile, each based upon the same distribution of lifetime excess cancer risks for an exposed individual..." (OAR 340-122-115(2)(b)).

## Suppression effects

For Native American populations living in Washington, evaluating fish consumption rates using common survey methodology may be problematic.<sup>216</sup> Surveys and the exposure models they develop provide information only about current consumption patterns. The number of tribal members practicing subsistence lifestyles is below known historical levels. Survey data does not provide information on historical fish consumption rates and resource use, which may be more indicative of consumption rates.

Researchers suggest that suppression happens for various reasons.<sup>217</sup> Two reasons are contamination and lower abundance. When the fish are contaminated or absent, tribal members may eat less fish and/or substitute other types of fish. While, historically, fish provided the main dietary source of protein, this is true today for only a small subset of the tribal population.<sup>218,219, 220</sup>

Tribal health experts suggest that current tribal fish consumption rates are suppressed due to diminished access to historical quantities of fish and shellfish, and some researchers believe that historical rates represent the appropriate baseline level of consumption.

Although Ecology acknowledges this is an area of considerable importance to Washington tribes, suppression effects were not included in developing a default fish consumption rate for use in Washington.

## Summary and conclusions

Ecology's preliminary recommendations are for a health-protective and technically defensible default fish consumption rate or rates for use in regulatory decision making.

- Washington has the resources to support a variety of large fish/shellfish populations.
- Washington has a significant number of fish consumers as well as high fish-consuming populations.
- Washington has fish dietary survey information that quantifies the fish-consuming habits and patterns.
- Fish dietary survey information for state consumers technically defensible and sufficiently quantifies amounts and types of fish consumed.

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<sup>216</sup> Donatuto and Harper, 2008. Jamie Donatuto and Barbara L. Harper. Issues in Evaluating Fish Consumption Rates for Native American Tribes. Perspective. Risk analysis, Vol. 28, No. 6, 2008, pages 1497-1506.

<sup>217</sup> Donatuto J., Harper, B. "Issues in Evaluation Fish Consumption Rates for Native American Tribes." *Risk Analysis*. Vol. 28, No. 6, 2008.

<sup>218</sup> Harper B., Harris S. "A possible approach for setting a mercury risk-based action level based on tribal fish ingestion rates." *Environmental Research*, 107 (2008) 60-68.

<sup>219</sup> Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Principal Investigator: Barbara L. Harper, Oregon State University Department of Public Health and Confederated Tribes of the Umatilla Indian Reservation; Co-Investigators: Ana K. Harding, Oregon State University Department of Public Health; Therese Waterhouse, Oregon State University Department of Nutrition and Exercise Sciences; Stuart G. Harris, Confederated Tribes of the Umatilla Indian Reservation. August 2007.

<sup>220</sup> Stuart Harris and Barbara L. Harper. Lifestyles, diets, and Native American Exposure Factors Related to Possible Lead Exposures and Toxicity. *Environmental Research*, Section A, 86, pages 140-148, 2001

- Fish dietary survey information for Washington fish consumers provides a sound technical basis to make informed risk management decisions protective of human health.
- Fish dietary survey information for Washington fish consumers clearly indicates that Washington has a large fish-consuming population that consumes fish in larger amounts than the current default fish consumption rates.
- Selection of Washington default fish consumption rate and consideration of the range of fish consumption rates is consistent with state and federal regulatory policies and procedures.
- Selection of Washington default fish consumption rate and consideration of the range of fish consumption rate considers Native American tribal treaty-reserved rights.

# Appendices

## Appendix A

### Data Used to Develop Proposed Default FCR

Information used by Ecology for developing a proposed default fish consumption rate appropriate for regulatory use in Washington.

**Table A-1. Summary of Fish Consumption Rate Data**

	Population Surveyed	Type of Fish Included in Survey	Number of Adults Surveyed	Descriptive Statistics (g/day)					
				Mean	Median	Percentiles			
						75 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	99 <sup>th</sup>
Data from dietary recall surveys	Tulalip Tribe	Finfish (anadromous & estuarine) Shellfish	73	72	45	85	186	244	312
	Suquamish Tribe	Finfish (anadromous & estuarine) Shellfish	284	214	132	-	489	-	-
	Squaxin Island Tribe	Finfish (anadromous & estuarine) Shellfish	117	73	43	-	193	247	-
	Columbia River Tribes	Finfish (anadromous & freshwater)	512	63	40	60	113	176	389
	Asian & Pacific Islanders	Finfish (anadromous & estuarine) Shellfish	202	117	78	139	236	306	-
EPA estimate Fish consumers in the U.S. general population <sup>221</sup>		Finfish (anadromous, estuarine, marine, & freshwater) Shellfish	2585	127	99	-	248	334	519
Source: Adapted from Table 3, page 28, Human Health Focus Group Report, Oregon Fish and Shellfish Consumption Rate Project, Oregon Department of Environmental Quality, June 2008. Blank cells indicate data not available.									

<sup>221</sup> The national per capita fish consumption data was collected using a methodology distinctly different than the five dietary recall surveys. It is included here for comparison purposes. It indicates that although the method of collecting the data differs, the results are generally consistent

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## Appendix B

### Additional Supporting Information

#### Children's fish consumption rates

- The EPA 2008 Child-Specific Exposure Factors Handbook and the EPA 2009 Highlights of the Child-Specific Exposure Factors Handbook summarizes children's fish consumption rates for different age groups. The mean and 95<sup>th</sup> percentile consumer only total fish (marine, estuarine, freshwater) consumption rate for 16 to <18 years of age for the general population is 2.1 g/kg-day (136 g/day) and 6.6 g/kg-day (357 g/day), respectively.<sup>222,223</sup> The mean and 95<sup>th</sup> percentile consumer only total fish (Fish and Shellfish) consumption rate for 3 to <6 years of age for the general population is 4.2 g/kg-day (78 g/day) and 10 g/kg-day (186 g/day), respectively.<sup>224</sup> The EPA 2002 Interim Report Child-Specific Exposure Factors Handbook summarizes the fish consumption rates among Native American children (consumers only, 5 or 6 years old or younger) using Pacific Northwest fish consumption survey information (table below).

**Table B-1. Fish Consumption Rates of Native American Children 5 or 6 Years of Age or Less**

Survey (Native Populations)	Mean (g/day)	90th Percentile (unless otherwise noted, g/day)	95th Percentile (g/day)
CRITFC, 1994 (Umatilla, Yakama, Nez Perce, Warm Springs)	25	63	73
Toy et al., 1996 (Tulalip and Squaxin Island Tribes) <sup>a</sup>	11	21 (86 <sup>th</sup> percentile)	
Suquamish Tribal Survey, 2000 <sup>b</sup>	21	48	103

a: Consumption rate calculated using the average body weight of 15.2 kilograms reported in Toy et al, 1996.  
b: Consumption rate calculated using the average body weight of 14.1 kilograms from the general population.

Although the age groups and body weights may differ across the general and Native American children population groups, the fish consumption rates for the children begin to approximate one another at the upper percentiles (78 to 186 g/day and 63 to 103 g/day). EPA has noted that there is a high degree of variability for fish consumption rates across the Pacific Northwest tribes.<sup>225</sup> The 2008 Oregon DEQ Human Health Focus Group Report referenced EPA 2002 Per Capita Fish Consumption in the U.S. as support documentation for the children's fish consumption rate (consumers only) of 191 g/day.<sup>226,227</sup> The same documentation and children's fish consumption

<sup>222</sup> U.S. Environmental Protection Agency. Child-Specific Exposure Factors Handbook. (Final Report) EPA/600/R-06/096F. September 2008 [<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=199243>]

<sup>223</sup> U.S. Environmental Protection Agency. Highlights of the Child-Specific Exposure Factors Handbook. EPA/600/R-08/135. August 2009

<sup>224</sup> U.S. Environmental Protection Agency. Highlights of the Child-Specific Exposure Factors Handbook. EPA/600/R-08/135. August 2009. Table 1, using a body weight of 18.6 kilograms for children 3 to <6 years of age.

<sup>225</sup> U.S. Environmental Protection Agency. Exposure Factors Handbook: 2009 Update. EPA/600/R-09/052A. July 2009.

<sup>226</sup> State of Oregon Department of Environmental Quality (Oregon DEQ). Human Health focus Group Report Oregon Fish and Shellfish Consumption Rate Project. June 2008

<sup>227</sup> U.S. Environmental Protection Agency. Estimated per Capita Fish Consumption in the United States. EPA-821-C-02-003. [Table 4, Section 5.2.1.1]

rate (190 g/day) is used in this support document to recognize the variability expressed by different fish consumption rates for different fish-consuming populations.

The following tables, excerpted from Moya, 2004 summarize fish consumption rate data analysis for surveys identified by Ecology as meeting measures of technical defensibility. These tables are included here to show age group data.

**Table B-2. Tribal Fish Consumption Rates** <sup>228</sup>

Fish consumption rate by age group from selected Pacific Northwest tribes				
	Mean	50 <sup>th</sup> Percentile	90 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile
<b>Tulalip Tribe, g/kg -day</b>				
Ages 0-5	0.2	0.08	0.7	
18-34		0.06	2.0	2.6
35-49		1.0	3.7	4.2
50-64		0.5	1.6	1.6
65 and over		0.2	0.6	0.6
Adults	0.9	0.6	2.9	
<b>Squaxin Tribe, g/kg -day</b>				
0-5	0.8	0.5	2.1	
18-34		0.5	2.3	3.1
35-49		0.5	2.6	3.0
50-64		1.1	3.6	3.6
65 and over		0.8	2.2	2.2
Adults	0.9	0.5	3.0	
<b>Suquamish Tribe, g/kg -day</b>				
0-6	1.5		3.4	
<b>Adult Males</b>				
16-42	3.3	2.3	8.6	13.0
43-54	5.2	4.6	10.3	
55 and over	1.6	1.4	4.8	
<b>Adult Females</b>				
16-42	1.9	1.0	4.9	10.1
43-54	1.2	0.8		
55 and over	3.7	2.1		
<b>Columbia River Basin Tribes, g/day</b>				
Adults	58.7			
18-39	57.6			
40-59	55.8			
60 and over	74.4			

<sup>228</sup> Moya, Jacqueline (2004) 'Overview of Fish Consumption Rates in the United States', Human and Ecological Risk Assessment: An International Journal, 10: 6, 1195-1211. Adapted from Table 5, page 1204.



**Table B-3. Fish Consumption Rate Data for Asian and Pacific Islanders<sup>229</sup>**

Asian and Pacific Islanders in King County, by age group (g/kg-day)	Mean	50 <sup>th</sup> %ile	90 <sup>th</sup> %ile	95 <sup>th</sup> %ile
All Respondents	1.9	0.8	2.4	3.9
18-29	1.8		2.1	3.9
30-54	1.6		2.3	3.8
55 and over	2.1		3.2	5.2

**Table B-4. EPA Data on Children's Fish and Shellfish Consumption Rates for the U.S. General Population<sup>230</sup>**

Fish Population Description	Fish Consumption by Age Group, g/kg-day			
	3 to < 6 years	6 to < 11 years	11 to < 16 years	16 to < 18 years
<b>Total Fish</b>				
Mean Per Capita	0.43	0.28	0.23	0.16
95 <sup>th</sup> %ile Per Capita	3.0	1.9	1.5	1.3
Mean Consumer Only	4.2	3.2	2.2	2.1
95 <sup>th</sup> %ile Consumer	10	8.7	6.2	6.6
<b>Marine Fish</b>				
Mean Per Capita	0.31	0.20	0.15	0.10
95 <sup>th</sup> %ile Per Capita	2.3	1.5	1.3	0.46
Mean Consumer Only	3.7	2.8	2.0	2.0
95 <sup>th</sup> %ile Consumer	9.3	8.0	5.2	6.5
<b>Freshwater Fish</b>				
Mean Per Capita	0.12	0.08	0.08	0.07
95 <sup>th</sup> %ile Per Capita	0.71	0.35	0.48	0.29
Mean Consumer Only	2.3	1.8	1.3	1.4
95 <sup>th</sup> %ile Consumer	7.2	6.2	4.4	3.3

## Data on Fish Species Consumed

The EPA Region-10 Framework for establishing site-specific FCRs for use at CERCLA sites provides the following information related to types of seafood consumed.

**Table B-5. Seafood Consumed by Adult Members of the Tulalip Tribe**

Seafood Category	Examples	Central Tendency Estimate (g/day)	95 <sup>th</sup> %ile (g/day)	Percent of fish diet
Anadromous Fish	Salmon/Steelhead	14.9	96.4	49.7
Pelagic Fish	Smelt, Mackerel, Cod, Perch	1.3	8.1	4.2
Benthic / Demersal Fish	Halibut, Sole, Rockfish, Snappers	1.2	7.5	3.9
Shellfish	Crabs, Clams, Mussels, Bivalves	12.5	81.9	42.2
Total Ingestion Rate		30	194	100

<sup>229</sup> Moya, Jacqueline (2004) 'Overview of Fish Consumption Rates in the United States', Human and Ecological Risk Assessment: An International Journal, 10: 6, 1195-1211. Adapted from Table 4, page 1203

<sup>230</sup> U.S. Environmental Protection Agency. Highlights of the Child-Specific Exposure Factors Handbook. EPA/600/R-08/135. August 2009. Adapted from Table 1, page 20. [www.epa.gov/ncea]

For adult members of the Tulalip Tribe, a 95<sup>th</sup> percentile total consumption rate of 194 g/d is obtained after adjusting the total consumption rate of 243 grams/day to include only fish and shellfish harvested from Puget Sound. This is based on information from the EPA Region 10 Framework<sup>231</sup> as cited in the Lower Duwamish Waterway Group Remedial Investigation Report Appendix B: Baseline Human Health Risk Assessment. Final November 12, 2007.

**Table B-6. Seafood Consumed by Adult Members of the Suquamish Tribe**

Seafood Category	Examples	95 <sup>th</sup> %ile (g/day)	Percent of fish diet
Anadromous Fish	Salmon/Steelhead	183.5	23.9
Pelagic Fish	Smelt, Mackerel, Cod, Perch	56.0	7.3
Benthic/ Demersal Fish	Halibut, Sole, Rockfish, Snappers	29.1	3.8
Shellfish	Crabs, Clams, Mussels, Bivalves	498.4	65
Total Ingestion Rate		766.8	100

For adult members of the Suquamish Tribe, a 95<sup>th</sup> percentile total consumption rate of 766.8 g/d is obtained after adjusting the total consumption rate of 796 grams/day to include only fish and shellfish harvested from Puget Sound. This is based on information from U.S. EPA Region 10 Framework<sup>232</sup> as cited in the Lower Duwamish Waterway Group Remedial Investigation Report Appendix B: Baseline Human Health Risk Assessment. Final November 12, 2007.

**Table B-7. Seafood Consumed by Adult Asian-Pacific Islanders (API)**

Seafood Category	Central Tendency Estimate (g/day)	95 <sup>th</sup> %ile (g/day)	Percent of fish diet
Anadromous Fish	0.56	5.5	9.6
Pelagic Fish	0.5	4.9	8.6
Benthic Fish	0.24	2.4	4.2
Shellfish	4.6	44.2	77.5
Total	5.9	57	99.9

Freshwater fish make up 8.3 percent of the API seafood consumption, based on information from the API fish consumption survey from King County, Washington, as cited in the Lower Duwamish Waterway Group Remedial Investigation Report Appendix B: Baseline Human Health Risk Assessment. Final November 12, 2007.

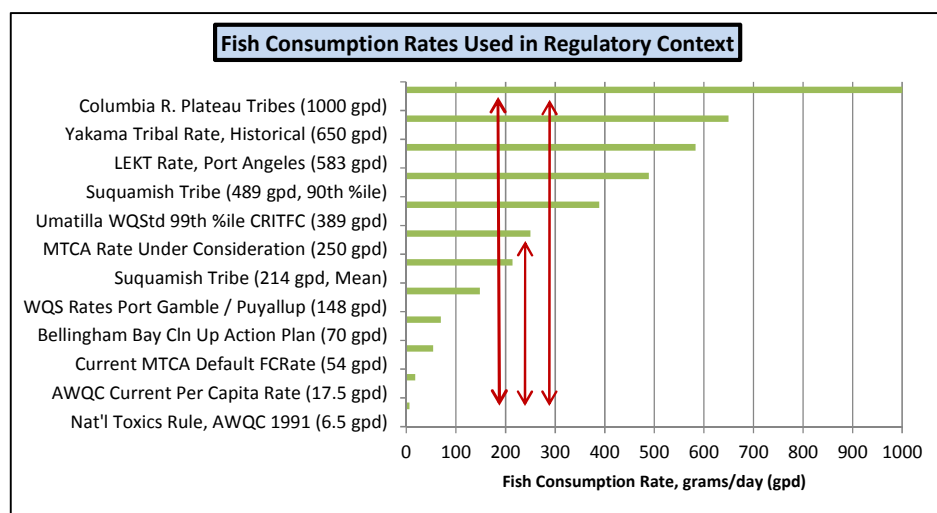
<sup>231</sup> U.S. Environmental Protection Agency, Region 10. Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia. August 2007.

<sup>232</sup> U.S. Environmental Protection Agency, Region 10. Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia. August 2007.

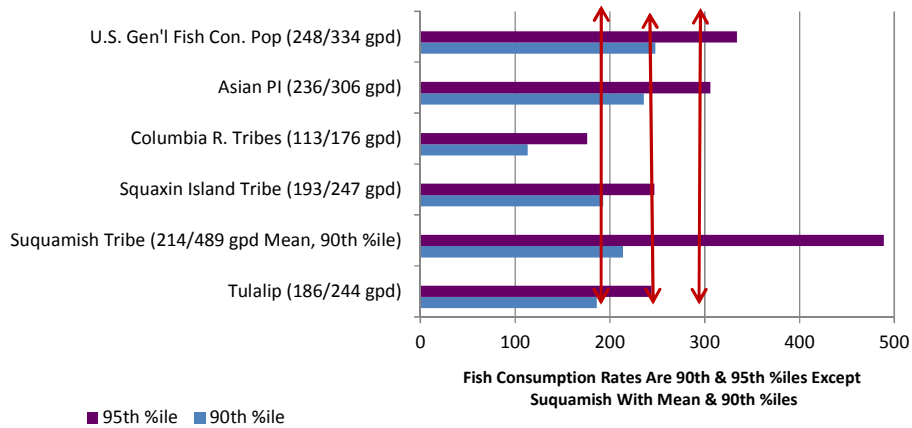
## Appendix C

### Graphics

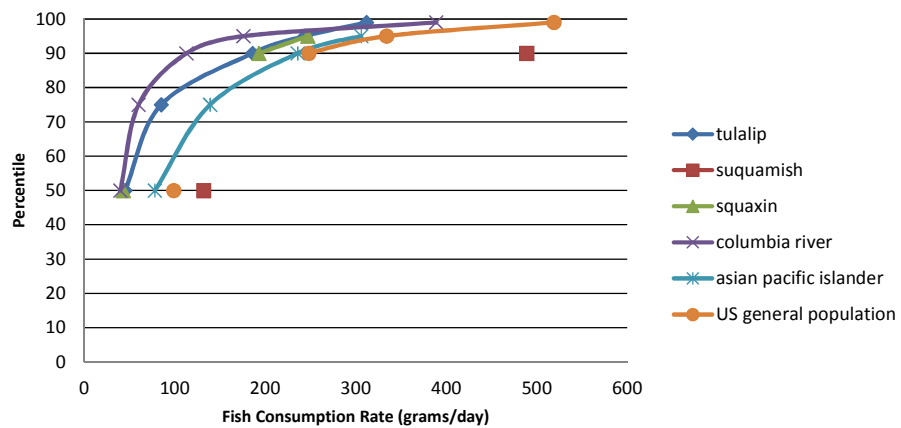
The following charts provide additional ways to view the information discussed in this report.

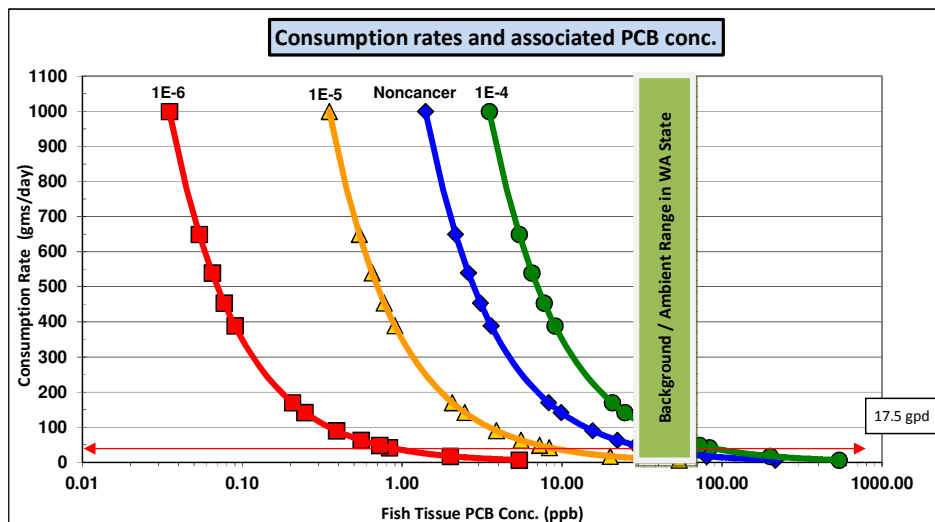


### 90th & 95th %ile of Adult Fish Consumption Rates from Pacific NW Surveys (grams/day, gpd)



### Distribution of Fish Consumption Rates for Different Populations





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## Appendix D

# EPA Region 10 Framework

The U.S. Environmental Protection Agency, Region 10, published in 2007 a decision-making framework for use in deriving fish/shellfish consumption rates to help support the cleanup of contaminated sites in Puget Sound and the Strait of Georgia up to the Canadian border.<sup>233</sup> The framework recognizes the limited seafood consumption information available. It supports site-specific regulatory cleanup decisions at the many hazardous waste sites located on tribal lands or within tribal fishing areas. The framework provides a consistent and protective approach to establishing fish consumption rates by identifying a tiered information hierarchy of preferred data:

6. Fish/shellfish consumption surveys from local watershed representative of the population being addressed for a water body
7. Fish/shellfish consumption surveys that reflect geography or population groups similar to those under evaluation
8. National food consumption survey information
9. Default values

The EPA Region 10 Framework uses the seafood consumption information from the Suquamish and the Tulalip Tribes to support the development of fish consumption rates for other fish (tribal) consuming populations.<sup>234</sup> The selection of the Suquamish or the Tulalip consumption information to be used as a surrogate for other tribal or fish-consuming populations is dependent on consideration of the following:

- Fish/shellfish abundance
- Fish/shelf habitat quality
- Fish/shellfish habitat quantity
- Careful consultation with fish/shellfish tribal biologists to make an informed decision regarding the selection of the dataset
- Historical patterns of fish/shellfish abundance and habitat quality

Selection of the Suquamish Tribe's dataset is most applicable to cleanup sites with the extensive intertidal habitat needed to sustain shellfish harvests. Selection of the Tulalip Tribe's dataset is most applicable where there is less shellfish habitat to sustain shellfish harvests.

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<sup>233</sup> U.S. EPA Region 10. Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia. U.S. Environmental Protection Agency, Region 10, Office of Environmental Assessment. August 2007

<sup>234</sup> Toy K, N.L. Polissar, S. Liao, G. Mittelstaedt

## Fish species

The EPA Region 10 Framework assumes all of the fish and shellfish harvested from the Puget Sound may be affected by site contaminants. Hence, unless there is site-specific information attributing salmon contaminant body burdens to site contaminants, salmon are included in the overall fish consumption rate. Consistent with U.S. EPA regulatory policies, procedures, and guidance, the fish consumption rates used in framework were based on the 95<sup>th</sup> percentile from the Suquamish or Tulalip consumption dataset (uncooked weight, harvested from Puget Sound). The fish consumption rates are categorized for various species: salmon, pelagic fish, bottom fish, and shellfish. The total fish/shellfish ingestion rates for the two tribes are adjusted to include only fish and shellfish harvested from Puget Sound.

The table below provides the Tulalip Tribe's fish consumption rate and percent of diet assumed by the species tabulated in the EPA Region 10 Framework. The total unadjusted fish/shellfish consumption rate for the Tulalip Tribe is 243 grams/day. The average Tulalip adult body weight used to derive the grams/day fish consumption rate was 81.8 kilograms.

**Table D-1. Tulalip Tribe's Fish Consumption Rate (grams/day)**

Species Category	Fish Consumption Rate	Percent of diet
Salmon	96.4	49.7
Pelagic Fish	8.1	4.2
Bottom	7.5	3.9
Shellfish	81.9	42.2
Total Ingestion Rate w/ Salmon	194	100
Total Ingestion Rate w/o Salmon	98	

Adapted from Table B-1, EPA Region 10 Framework

The table below provides the Suquamish Tribe's fish consumption rate and percent of diet assumed by the species tabulated in the EPA Region 10 Framework. The total unadjusted fish/shellfish consumption rate for the Suquamish Tribe is 796 grams/day. The average Suquamish adult body weight used to derive the grams/day fish consumption rate was 79 kilograms.

**Table D-2. Suquamish Tribe's Fish Consumption Rate (grams/day)**

Species Category	Fish Consumption Rate	Percent of diet
Salmon	183.5	23.9
Pelagic Fish	56.0	7.3
Bottom	29.1	3.8
Shellfish	498.4	65
Total Ingestion Rate w/ Salmon	766	100
Total Ingestion Rate w/o Salmon	583	

Adapted from Table B-2, EPA Region 10 Framework

The EPA Region 10 Framework has been applied to support cleanups of the following Washington sites:

- The Lower Duwamish Waterway and associated sites along the waterway
- Port Angeles ITT Rayonier
- Puget Sound Naval Shipyard



## Appendix E

### The Question of Salmon

#### Inclusion of salmonids in a Washington default fish consumption rate (or rates)

Ecology reviewed information related to salmon stocks and salmon available for harvests throughout Washington. The available Pacific Northwest dietary fish consumption surveys, with a focus on the Puget Sound fish consumption, document salmon as one of many fish species consumed by Washington fish consumers. Salmon are harvested by both recreational and commercial fishers. Although most (but not all) salmon spend their adult lives in open ocean waters away from local contamination sources, salmon are exposed to contamination and fish tissue analysis shows salmon to be a source of exposure. Ecology believes that salmon should be included in the Washington default fish consumption rate because:

- There are sufficient quantities of salmon and salmon stocks for harvesting throughout Washington.
- Salmon are an important Native American cultural icon with religious significance for Washington tribes.<sup>235</sup>
- Salmon are harvested for recreational, Native American general and subsistence diets, and commercial consumption.<sup>236</sup>

In 2008, the MTCA Science Advisory Board (SAB) considered the question of including or excluding salmon when setting a site specific fish consumption rate for the Lower Elwha Klallam Tribe (LEKT) in Port Angeles Harbor. The LEKT had proposed excluding salmon from their tribal-specific fish consumption rate based on assumptions that salmon spend much of their lives in the open ocean and acquire most of their contaminant body burden of persistent bioaccumulative chemicals in marine environments away from the contaminated site.

The SAB asked Ecology to look further into these assumptions. Ecology's report in response is posted in the June 2, 2008, meeting materials.

Salmon have a very complex life cycle, and survival strategies vary across and among different salmonid species.<sup>237</sup> The geographic distribution of Pacific salmonids extends from San Francisco Bay northward along the Canadian and Alaskan coasts to rivers, draining into the Arctic Ocean, and southward down the Asian coastal areas of Russia, Japan, and Korea.

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<sup>235</sup> Donatuto and Harper, 2008. Jamie Donatuto and Barbara L. Harper. Issues in Evaluating Fish Consumption Rates for Native American Tribes. Risk Analysis, Vol. 28, No. 6, 2008. Pages 1497-1506.

<sup>236</sup> Washington Department of Fish and Wildlife. Salmon Recovery. Provides information on Hatcheries, Harvests, Salmon Recovery Plans, Salmon Habitat, and a variety of other salmon related information. Web location: <http://wdfw.wa.gov/recovery.htm>

<sup>237</sup> Quinn, Thomas P. 2005. *The Behavior and Ecology of Pacific Salmon & Trout*. American Fisheries Society. University of Washington Press. 2005.

Persistent bioaccumulative toxics (PBTs) exist within the environment for long periods of time. They are lipophilic, bioaccumulate in fish tissue and animal fat, and are highly toxic to animals and humans. All seven Pacific salmon species are biotransporters of pollutants between the Pacific Ocean and their spawning sites in freshwater.<sup>238</sup> Although variation exists, generally, chinook, coho, and steelhead have migratory patterns along the Pacific continental shelf and remain in freshwater and estuarine environments for longer periods of time than the other Pacific salmonid species. Pink, chum, and sockeye salmon enter the ocean environment and rapidly migrate northward and westward through coastal waters of North America; they are found in the open waters of the North Pacific, Gulf of Alaska, and the Bering Sea by the end of their first year at sea. (See table below.)

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Salmonid Life Cycle Environment <sup>238</sup>	Salmon Species						
	Chinook	Coho	Sockeye	Chum	Pink	Steelhead	Cutthroat
Riverine Rearing	x	x	x			x	x
Estuarine Rearing	x	x	x			x	x
Lacustrine Rearing			x				x
Nearshore Migration	x	x	x	x	x	x	x
Continental Shelf Migration	x	x				x	
Mid-Oceanic Migration			x	x	x		

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<sup>238</sup> During river ascent, salmonids use their muscle lipid and triacylglycerol deposits for energy and gonadal development. Particularly in female salmonids, the organic pollutant body burden redistributes and accumulates in the lipid-rich gonads and salmon roe. Furthermore, the lipid depletions and redistribution during the river ascent is not coupled with a simultaneous elimination of the organic pollutant body burden in the salmonids. The pollutants in the salmonids are readily available for bioaccumulation because the migrating salmonids, the salmon roe, and salmon carcasses are a direct food source for predators (birds, mammals, and other fish). Hence, salmonids redistribute their pollutant body burdens back to their spawning grounds, to the open ocean predators, or bioaccumulate in the food web. The redistribution, biotransportation, and bioaccumulation of the salmonid pollutant body burden helps contribute to contaminated food webs. [Ewald, Göran, Per Larsson, Henric Linge, Lennart Okla, and Nicole Szarzi. "Biotransport of Organic Pollutants to an Inland Alaska Lake by Migrating Sockeye Salmon (*Oncorhynchus nerka*).<sup>238</sup> Arctic, Volume 51, No. 1, pages 40-47. March 1998. ]

<sup>239</sup> 2007 Puget Sound Update. *Ninth Report of the Puget Sound Assessment and Monitoring Program*. Puget Sound Action Team. Publication No. PSAT 07-02.

## Pacific Salmon in Washington waters

Ecology has reviewed information related to salmon stocks and salmon available for harvests throughout Washington.

- *Available dietary surveys indicate that Washington residents eat salmonids.* There are sufficient numbers of salmon and salmon stocks for harvesting throughout Washington; Salmonids are harvested for recreational, Native American general and subsistence diets, and commercial consumption.<sup>240</sup> The available Pacific Northwest consumption surveys, with a focus on the Puget Sound fish consumption, documents salmon as one of many fish species consumed by Washington fish consumers.
- *Elevated levels of hazardous substances have been measured in salmonids may contribute to the contaminant body burden of fish-consuming populations.* Because of their chemical-physical properties, persistent bioaccumulative toxics (PBTs) are a group of chemicals that exists within the environment for long periods of time, are lipophilic and bioaccumulate in fish tissue and animal fat, and are highly toxic to animals and humans.<sup>241</sup> The unique geologic and hydrogeologic nature of the Puget Sound in combination with the bioaccumulative, persistent, and toxicity of the PBT - type contaminants creates additional risks to the Puget Sound ecosystem. Some of the PBTs that continue to contaminate, threaten, or harm the Puget Sound ecosystem include: polychlorinated biphenyls (PCBs); polycyclic aromatic hydrocarbons (PAHs); dioxins and furans; polybrominated diphenyl ethers (PBDEs); and hormone-disrupting chemicals (e.g., bisphenol A). PBTs are contaminants throughout the entire pelagic food web in the Puget Sound.<sup>242</sup>
- Of the different PBTs that permeate the Puget Sound food web, polychlorinated biphenyls (PCBs) are well documented contaminants in coho and Chinook Pacific salmon collected from various in-river and marine locations in Puget Sound.<sup>243</sup> Pacific salmon exposure to PBTs, and PCBs in particular, are, in part, contingent on migratory patterns, residency time in Puget Sound, proximity of the salmon to contaminated sediments, waste sites, and different behavior and dietary patterns as the fish mature.
- This is a health protective approach that recognizes the uncertainty and variability in the sources of elevated hazardous substances in salmonid tissues. There is large uncertainty and variability in the source of elevated levels of hazardous substances in salmonid tissue.

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<sup>240</sup> Washington Department of Fish and Wildlife. Salmon Recover. Provides information on Hatcheries, Harvests, Salmon Recovery Plans, Salmon Habitat, and a variety of other salmon related information. Web location: <http://wdfw.wa.gov/recovery.htm>

<sup>241</sup> 2007 Puget Sound Update. Ninth Report of the Puget Sound Assessment and Monitoring Program. Puget Sound Action Team. Publication No. PSAT 07-02.

<sup>242</sup> IBID.

<sup>243</sup> O'Neill, Sandra M., James E. West, James C. Hoeman. *Spatial Trends in the Concentration of Polychlorinated Biphenyls (PCBs) in Chinook (Oncorhynchus tshawytscha) and Coho Salmon (O. kisutch) in Puget Sound and Factors Affecting PCB Accumulation: Results from the Puget Sound Ambient Monitoring Program.* Published in Puget Sound Research '98 Proceedings, Seattle, Washington, Volume 1, pages 312-328, 1998.

Although there is evidence that salmon accumulate much of their body burden while at sea, there appears to be some variability across species.

- O'Neill et al. (1998), report that "...Chinook and coho salmon accumulate most of their PCB body-burden in the marine waters of Puget Sound and the ocean, and because Chinook salmon live longer and stay at sea longer than coho salmon they accumulate higher PCB concentrations in their muscle tissues."<sup>244</sup> The authors further noted that the salmon contaminant body burden attributable to freshwater and estuarine environments was negligible compared to residency time, growth patterns, and feeding habits of the salmon at sea.
- Quinn (2005) notes that salmon have high metabolic rates, feed heavily and grow fast in the ocean.<sup>245</sup> Salmon can double their body length and increase their body weight by tenfold during their first summer at sea. More than 98 percent of the final body weight of most salmon is attained at sea. For example, pink salmon entering the ocean may have a body weight of 0.2 grams but return from the sea weighing 2 kilograms, a ten thousand fold increase.
- O'Neill et al. (2006)<sup>246</sup> observed that Chinook salmon populations that spend more time in Puget Sound have higher tissue concentrations of PCBs compared to Chinook populations from coastal regions. Variations in the contaminant body burdens were noted and attributed to the marine distribution of the populations.
- The MTCA Science Advisory Board recognized this uncertainty and variability and further noted that it is not possible to quantitatively determine the contaminant body burden in salmon attributed to a particular site.<sup>247</sup> The MTCA Science Advisory Board agreed that "it is reasonable to conclude that salmon body burden is above zero; however, currently Board members do not have enough information to say how much above zero."<sup>248</sup>
- *A process for making site-specific decisions on including/excluding salmon would be difficult to implement within the Clean Water Act framework.* EPA's Decision Framework establishes criteria for making site-specific decisions on including/excluding salmon when making decisions at federal cleanup sites. However, such an approach would be difficult and cumbersome to implement within the framework of the SMS and WQS rules.
- This health protective approach is consistent with the recommendations of the Oregon DEQ Human Health Focus Group.
- Salmonids are an important Native American cultural icon with religious significance for Washington tribes.

## Salmon Stock Inventory

<sup>244</sup> Chinook and coho salmon occupy three distinct habitat types during their lifecycle: a. Freshwater habitats (eggs hatch & fry develop); b. Puget Sound (smolts enter marine waters to feed & reside during migration); c. Ocean habitat (O'Neill et al., 1998).

<sup>245</sup> Quinn, Thomas P. 2005. *The Behavior and Ecology of Pacific Salmon & Trout*. By Thomas P. Quinn, American Fisheries Society in Association with University of Washington Press. 2005.

<sup>246</sup> O'Neill et al., 2006. Regional patterns of persistent organic pollutants in five Pacific salmon species (*Oncorhynchus* spp) and their contributions to contaminant levels in northern and southern resident killer whales (*Orcinus orca*). Extended Abstract in 2006 Southern Resident Killer Whale Symposium. April 3-5, 2006.

<sup>247</sup> MTCA Science Advisory Board, March 11, 2008 Meeting Summary and MTCA Science Advisory Board, June 02, 2008 Meeting Summary.

<sup>248</sup> MTCA Science Advisory Board, June 2, 2008 Meeting Summary, page 6 to 7.

Salmon Stock Inventory (SaSI) 2002 identifies salmon and steelhead stocks in Washington, rates their status, and characterizes their origin and type. Only those stocks that spawn within Washington are included. The SaSI includes bull trout, Dolly Varden, and the coastal cutthroat stock inventories published from 1997, 1998, and 2000 inventories.<sup>249</sup> The Washington regional 2002 totals for salmon and steelhead stocks are detailed below.

There are 443 different total salmon and steelhead stocks in Washington with selected regional breakdown totals as follows:<sup>250</sup>

**Table E-1. Regional Breakdown of Salmon and Steelhead Stocks**

Stock	Puget Sound Region Stock Totals	Washington Coastal Areas	Columbia River Basin Areas
Chinook	27	30	48
Chum	67	14	2
Coho	45	31	18
Pink	15	0	0
Sockeye	4	3	2
Steelhead	60	3	37

## Washington Water Resource Inventory Areas

Washington's 11 species and subspecies of native salmonid fish are under pressure from human population growth and development. Urban and industrial land conversion, forestry and agricultural practices, water diversion, municipal water demands, overfishing, and hydropower development have contributed to the decline of salmonid stocks. There are 62 Water Resource Inventory Areas (WRIAs) in Washington. Of the 62 WRIAs in Washington the following selected WRIAs have no anadromous salmonid stock inventories:<sup>251</sup>

- WRIA 41 – Lower Crab
- WRIA 50 – Foster
- WRIA 51 – Nespelem
- WRIA 53 – Lower Lake Roosevelt
- WRIA 54 – Lower Spokane
- WRIA 60 – Kettle
- WRIA 61 – Upper Lake Roosevelt
- WRIA 62 – Pend Oreille
- WRIA 55 – Little Spokane
- WRIA 57 – Middle Spokane

<sup>249</sup> Salmonid Stock Inventory (SaSI) 2002 Introduction web location: [http://wdfw.wa.gov/fish/sasi/sasi\\_2002\\_introduction.pdf](http://wdfw.wa.gov/fish/sasi/sasi_2002_introduction.pdf)

<sup>250</sup> Salmonid Stock Inventory (SaSI) 2002 Introduction web location: [http://wdfw.wa.gov/fish/sasi/sasi\\_2002\\_introduction.pdf](http://wdfw.wa.gov/fish/sasi/sasi_2002_introduction.pdf) (total based on Table 1, page 5).

<sup>251</sup> Selected trout species may be considered salmonids and may be located in these WRIAs

- WRIA 56 – Hangman
- WRIA 34 – Palouse

Each of the Washington WRIAs provides a complete listing of the regions SaSI stocks.<sup>252</sup> WRIA with no salmonid stock inventories suggests that these areas have insufficient water resources for salmon migration, the water resources may have been diverted or blocked by dams, or there may be insufficient habitat to sustain the populations.

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<sup>252</sup> Salmonid Stock Inventory (SaSI) 2002 Water Resource Inventory Area (WRIA) Map located at the web location:  
<http://wdfw.wa.gov/fish/sasi/>

## Appendix F

# Washington Tribes

### Washington Indian Tribes and Treaty Reserved Rights

There are 29 federally recognized tribes in Washington.<sup>253</sup> See **Figure AAA** for a map of showing the location of Indian reservations. Through treaties, executive orders and customs, tribes have maintained their use of native fisheries for trade, subsistence, religious and ceremonial use from time immemorial. Because of this, tribal communities represent one of the most sensitive populations for fish consumption rates.

#### Tribal Governments

The principles of tribal sovereignty, federal trust responsibility, and reserved rights are grounded in the United States Constitution, treaties, executive orders, federal statutes, and various court decisions.<sup>254</sup> These sources of federal Indian law provide for the unique sovereign status of federally recognized tribes and distinguish tribes from other ethnic minority populations in the United States.

Under the Clean Water Act, tribes are eligible to receive “treatment as a state” status and to adopt water quality standards with Environmental Protection Agency approval. A number of tribes in Washington have approved water quality standards, including established fish consumption rates for reservation waters (<http://water.epa.gov/scitech/swguidance/standards/wqslibrary/tribes.cfm#r10>). Tribes are effectively neighboring states for the purposes of the Clean Water Act and cross border flows.

#### Usual and Accustomed Fishing Rights

Through treaties and executive orders, tribes ceded or relinquished most of what is now Washington to the U.S. in exchange for permanent reservation homelands and certain services. In addition, many tribes retained their right to utilize the fisheries resources throughout their aboriginal areas. Washington Territorial Governor Isaac Stevens, in 1854 and 1855, negotiated treaties with most of the tribes of Washington and concluded treaties with 21 tribes. Under the Stevens’ treaties, tribes ceded vast areas of what is now Washington State to the United States while reserving certain off-reservation rights including the right to take fish in their “usual and accustomed” places and the right to hunt on “open and unclaimed lands”. In addition to 21 tribes in Washington, three tribes located in other states have ceded and usual and accustomed fishing areas in Washington.

The Stevens negotiated treaties included the following provision or some similar type of provision:

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<sup>253</sup> Governor’s Office of Indian Affairs, July 2010 access to web link: <http://www.goia.wa.gov/Tribal-Information/Map.htm>

<sup>254</sup> United States Constitution, Article VI, Section II states that, “...all treaties made, or which shall be made under the authority of the United States, shall be the supreme law of the land; and the judges in every state shall be bound thereby, anything in the Constitution or laws of any State to the contrary notwithstanding.”

“The exclusive right of taking fish in all the streams, where running through or bordering said reservation, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at all usual and accustomed places, in common with Citizen of the Territory, and of erecting temporary buildings for curing them; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.”<sup>255</sup> <sup>256</sup>

Federal case law has established that this treaty provision reserved aboriginal rights for tribes to continue their harvest of fish in “usual and accustomed” areas. Shellfish are fish within the meaning of the Indian treaties and treaty reserved rights to harvest fish includes the harvesting of shellfish in “usual and accustomed grounds and stations.”<sup>257</sup> Tribal treaty fishing areas may overlap with one another and may have geographical extensions beyond tribal ceded areas.

Most areas of Washington include areas where tribes have traditionally harvested fish and shellfish and continue to do so by custom and under treaty reserved rights. Treaty reserved rights to harvest fish and shellfish is particularly significant throughout the marine waters of Washington.

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<sup>255</sup> The Yakima Treaty, June 09, 1855. Treaty between the United States and the Yakama Nation of Indians. Concluded at Camp Stevens, Walla Walla Valley, June 9 1855. ARTICLE III. Web location for treaty: <http://www.ccrh.org/comm/mones/primary/yaktreaty.html>

<sup>256</sup> Nez Perce Treaty, 1855, ARTICLE 3 found at web location: <http://www.ccrh.org/comm/river/treaties/nexperce.htm>

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## Appendix G

### Glossary

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